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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 23 OCTOBER, 1940 NUMBER 10

STUDIES ON KERATOCONUS RELATIVE TO THE EFFECT OF PROLONGED APPLICATION OF PRESSURE*

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INTRODUCTION

A survey of the embryonic development, growth, and structure of the cornea together with a study of keratoconus, which includes the pathological physiology, is necessary in an attempt to understand the success of prolonged pressure in reducing the deformity in some instances. Only a small portion of this survey is included in the present report.

DEVELOPMENT AND GROWTH

In embryonic development, the anlage of the cornea is the tissue anterior to the cleft which expands and develops into the anterior chamber. It appears at the 18-mm. stage,[1] after the sixth week. At this stage the organ is composed of an undifferentiated surface ectoderm and an underlying embryonic mesoderm about two or three cells thick. The mesodermal cells adjacent to the cleft become arranged in a regular row of cells resembling epithelium, thus forming the mesenchymal epithelium or the so-called endothelium of the cornea. The more superficial mesodermal cells, which are to differentiate into substantia propria, are more numerous at the periphery, so that the embryonic cornea has a greater thickness peripherally than centrally, a relation maintained through life. Although the posterior basilar layer (Descemet's membrane) is recognizable at the 76-mm. stage,[2] during the thirteenth week, the anterior basilar layer (Bowman's membrane) is not evident until the 103-mm. stage,[1] during the fifteenth week. Elastic fibers are first visible during the fourth month.

At the 20-mm. stage, when the mesoderm of the embryonic cornea begins to differentiate, the entire eye is only about 0.8 mm. in diameter, and the anlage of the cornea is 0.19 mm. in diameter. The curve of the cornea must be sharp since the radius of the entire eye is only 0.4 mm. The radius of curvature of the cornea is the same as that of the sclera until the fifth month.[1] After birth, the total growth of the cornea is smaller than that of the eye as a whole. The change from the greater peripheral curve of the cornea in the infant to the greater central curve in the adult[3] indicates the presence of a physiological process of thinning.

TENSILE STRENGTH

Although the surface epithelium, the endothelium, the corneal nerves, Bowman's and Descemet's membranes (particularly the latter) all contribute to the strength of the cornea, the greatest amount of strength must lie in the substantia propria. The corneal stroma is

* From the Harvard Medical School and the Massachusetts Eye and Ear Infirmary. Presented before the Association for Research in Ophthalmology, New York, June 11, 1940.

composed not only of lamellae of collagenous fibers with sufficient interlacing to bind these layers firmly together, but also of elastic fibers, which can be demonstrated by careful staining technique.* These fibers, lying largely in layers parallel to the surface but running in all directions, are most numerous deep in the cornea.[4] An elastic network, which prevents overdistension, functions as a supporting tissue.[5] The corneal lamellae of regardless of the direction in which the section is cut, but they can be followed farther in posterior sections.[8] Since the lamellae do not vary greatly in depth, the increased thickness of the human cornea at the periphery is clearly the result of a larger number of lamellae here. These deep peripheral lamellae thin out centrally and end obliquely against Descemet's membrane[9] (fig. 2).

In an attempt to determine how much

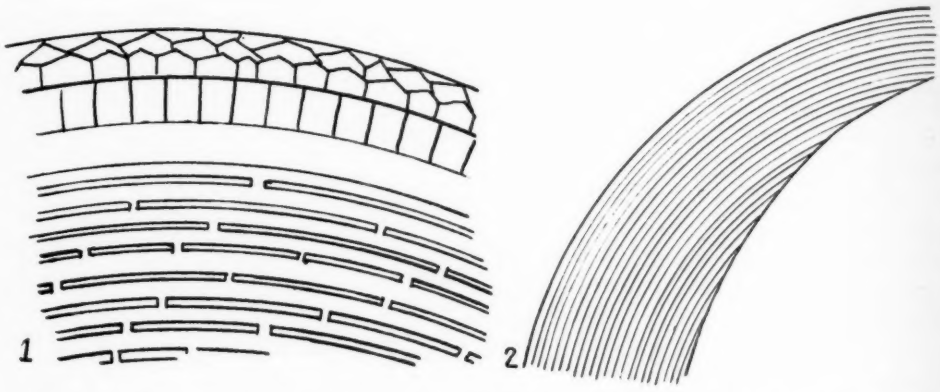

Fig. 1 (Terry and Chisholm). Diagram representing corneal lamellae not reaching entirely across cornea. No attempt has been made to maintain exact dimensional relationship. Any overdistension of the cornea breaking the connections and adherence between the lamellae would allow them to slide for a variable distance, resulting in an acute ectasia of the cornea. Were this sudden partial disjunction greater than Descemet's membrane could withstand, rupture of this membrane and of the subjacent mesenchymal epithelium would also occur, giving the typical picture of acute hydrops of the cornea.

Fig. 2 (Terry and Chisholm). Diagram to represent greater thickness of the cornea at the periphery attained by an actual increase in the number of lamellae. These lamellae, placed deep in the stroma, play out centrally and end obliquely against Descemet's membrane.

1[6] to 1.3[4] micra in thickness show little crossing of fibrils in a band,[7] but there is considerable interweaving between the bands themselves,[8] especially in the anterior one third to one half of the cornea.[9] In addition to the fibers which bridge across from one lamella to another, the existence of a cement substance is postulated by some observers.[9] In all layers of the cornea, lamellae never reach entirely across the cornea (fig. 1), ending sharply

force is needed to tear a cornea and just how it does tear, strips of 3-mm. wide rabbit's cornea and 2-mm. wide pig's cornea were placed in a Scott tester,** inclined plane type No. 2. The rabbit's cornea tore under 1,075 grams' weight (fig. 3). Results of the test on the pig's cornea were discarded because its thickness

* See Figure 10, Plate 9, in the article by Seefelder in the Archiv für Ophthalmologie, 1910, v. 73, p. 188.

** We are indebted to Professor E. R. Schwartz and Mr. H. H. Broadfoot of the Department of Textile Technology of the Massachusetts Institute of Technology for their helpful advice and technical application of this test.

prevented the use of the instruments available. From this study it appears that the cornea stretches some 10 percent before it tears. The tear is cup and cone shaped appearing as a "V" in cross section, a type of tear considered by those working in textiles as normal and satisfactory (fig. 4). It must be remembered that the rabbit's cornea is considerably thicker than a human cornea. No attempt was made to determine individual variation of rabbit's cornea based on age, sex, and weight, which would be important if one were attempting to correlate such a study with a study of the human cornea. Based on this finding, the cornea would not rupture until a pressure of 697 mm. of mercury was reached.* Cogan** has found that the rabbit's cornea has withstood up to 600 mm. of mercury pressure without rupture.

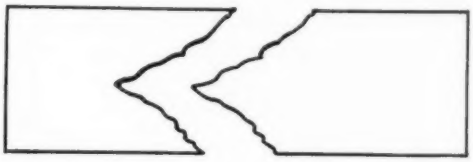

Fig. 4 (Terry and Chisholm). Diagram showing design of tear of corneal strip. Note cup and cone shape.

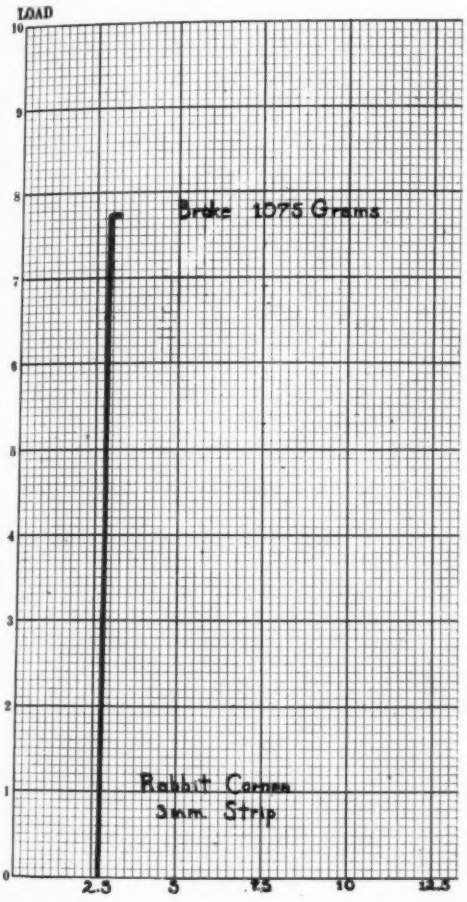

Fig. 3 (Terry and Chisholm). Graph showing typical results of testing tensile strength of a 3-mm. strip of rabbit's cornea. Ordinate is in grams and abscissa in millimeters.

Historical

MacKenzie[10] credits Léveillé with the first mention of keratoconus in scientific literature in 1802. Demours,[11] in 1818, not only describes the condition but states that when the cornea ruptures spontaneously "one can in general regard this as a happy termination." His further observations are more interesting. "When there is a beginning protuberance of the cornea, a sudden outpouring of lymph sometimes occurs at this place between the layers of the cornea. This partially

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* Derived as follows by Elek J. Ludvigh, 2d, Ph.D.: Although the inner surface of the cornea is not a part of a perfect sphere, the results are on an assumption that 0.6 cm. is the radius. The cornea would be 1.13 sq. cm. in area. The normal intraocular pressure of a rabbit equals 25 mm. mercury (Leber: Graefe Saemisch Handbuch). 25 by 13.6 (sp. gr. mercury) = 340 cu. mm. or 34 cu. cm. of water or 34 gm. per sq. cm. of base. 1.13 by 34 = 38.4 gm. for total cornea. The corneal strip broke at 1,075 gm. 1,075 ÷ 38.4 = 27.9 times. As 25 mm. of mercury = normal pressure, the pressure ∴ 25 by 27.9 = 697 mm. of mercury, the expected pressure at which the cornea would rupture.

** Cogan, D. G.: Personal communication.

disorganized state is not always an obstacle to the return of transparency but the re-establishment takes slightly longer or is not always complete." MacKenzie[10] in 1833 noted that the condition was not dependent on any (abnormal) pressure of the aqueous humor. He thought it was caused by some inordinate or irregular action of nutrient vessels of the cornea itself. Littell[12] in 1837 gave a good description of the clinical appearance. Desmarres d'Evreux[13] in 1847 pointed out that the condition had increased from severe vomiting in seasickness and from coughing. He also mentioned a case described by Bergman in which the condition was induced by hanging. During the same year Dix[14] was the first in this country to recommend daily puncture of the cornea with a cataract needle as an effective treatment. Nottingham[15] in 1854 first differentiated clearly between keratoconus and staphyloma. The tendency of the apex of the cone to be below the center of the cornea was attributed to the pressure of the upper lid by Noyes[16] in 1890.

Occurrence

Conical cornea, which manifests itself rarely before puberty and early adult life, appears to be more frequent in women than in men. Although keratoconus usually develops spontaneously, it tends to be increased by pregnancy.[17]

The apparent great rarity of conical cornea is misleading. Of those individuals who have well-developed unilateral keratoconus at least half show mild but definite conical cornea in the other eye. In fact, a small degree of conical cornea is often found in patients with astigmatism of three diopters or more, especially if at least one axis is myopic. This observation is consistent with the finding that many people with conical cornea of moderate amounts, when little or no scarring of the cone is present, can be given normal vision with a strong concave cylindrical and a convex or concave spherical correction, the cylinder often reaching nine diopters in strength.

Etiology

In our experience we have never seen any familial or hereditary relation. One patient, whose grandparents were Mormons, had many close relatives, none of whom showed any evidence of conical cornea, a fact verified by ophthalmological examinations. From the literature, however, it is evident that familial characteristics and heredity do play a part in the etiology in certain instances. Sander[18] reported the presence of keratoconus in a father and three daughters. Mann,[19] from records available, considers keratoconus to be a recessive or an irregular dominant in certain cases, even appearing as a unilateral defect in all members of a family. deSchweinitz[20] believed in an hereditary factor and Graves[21] believed that heredity could be considered the main cause in the development of the condition. He cited Jaensch[22] as his reference. Pagenstecher[23] found associated congenital anomalies, mentioning peripheral lenticular opacities of a star form in 11 patients with conical cornea when the pupil was dilated, and remnants of the pupillary membrane in four cases.

An hereditary weakness need not manifest itself until increasing stresses and strains of life reach sufficient volume to cause the inherently weak tissue to give way, an explanation applicable to progressive myopia and certain forms of hernia. The stresses and strains in childhood, though proportionately great, actually increase as bodily strength and activity reach their climax. Probably intraocular pressure itself is not necessarily instrumental in producing the deformity, although the unusually high pressure resulting from heavy muscular effort or

from rubbing the eye vigorously may be the activating agent.

There are many theories based on various endocrine dysfunctions. Moehling[24] attributes a mesenchymal weakness to pituitary deficiency, a belief shared by Sanctes.[25] Dodge[26] found an increased glucose tolerance and administered antuitrin, which appeared to arrest the disease in two patients who showed no increase in conicity in a period of two years following the original report.*

The only evidence of gonad dysfunction is limited to Ellis,[27] who reported keratoconus in association with dysmenorrhea and menorrhagia. Increase in keratoconus so common in pregnancy may be related to changes in internal secretions or to the strain on the body as a whole from the physical burden of pregnancy and parturition. Whether relaxing may affect the cornea, causing an increase in an already existent keratoconus, is pure conjecture but worthy of consideration. This hormone, responsible for the relaxation of the symphysis pubis, pelvic ligaments, and possibly of other joints,[28] so strikingly illustrated in the pocket gopher and demonstrated in guinea pigs,[29] rabbits, cats, dogs, mares, and sows,[30] is also present to a slight degree in the early pregnancy of women.[31] Histological studies of the effect on pelvic ligaments in monkeys[32] as analyzed by Hartman and Straus do not appear applicable to the changes in keratoconus.

Hypothyroidism is mentioned by Graves.[21] Louis Dor[33] reports a case in which administration of thyroid extract relieved the endocrine dysfunction and the keratoconus.

Altered body metabolism favoring keratoconus is said to be poor nourishment, nervous instability, and anemia. Arthur A. Knapp[34] has considered calcium deficiency associated with vitamin deficiencies an important cause. He reported having produced keratoconus experimentally in dogs on diets deficient in this combination. However, Török and Redway[35] feel that calcium deficiency is not of etiological importance, a view shared by Sitchevska.[36] In an extensive investigation of one of our patients who had recently developed keratoconus in one eye and who later developed a less marked deformity in the other eye, Dr. J. C. Aub found in the blood a moderate increase of both phosphorous and calcium

The relation of avitaminosis to keratoconus is not proved. Much and Richards[37] observed keratoconus in rats, after a vitamin-A-free diet had been given up. Arthur A. Knapp,[34] however, is convinced that vitamins A and D are most important in the etiology of keratoconus.

If one agrees that elastic tissue is an important factor in the strength of the cornea, an elastic-tissue degeneration could be the cause of keratoconus. It is claimed by Oskar Gans[38] that the pathology of elastic atrophy of the skin, of which stria gravidarium is an outstanding example, is first a stretching of the elastic tissue only and later the breaking and degeneration of the tissue. Although Gans considers this to be a mechanical effect entirely, Jadassohn[39] thinks that hereditary and endocrine factors may play a part. Certainly all people do not develop stria from identical amounts of stretching of the skin. This may indicate a predilection, hereditary or otherwise. "Senile" atrophy of the elastic fibers of the skin can be found at times in people less than 30 years of age.[40] Pinguecula, an elastic degeneration,[41] can occur relatively early in life, and pseudoxanthoma elasticum,[42] another elastic-tissue degeneration, in this case on a definitely hereditary basis, occurs in young people.

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* Dodge: Personal communication.

Pathology

The essential lesion appears to be an abnormal yielding of the central portion of the cornea with a thinning in the center. In Bowman's[43] case the thinning began at the base of the cone and increased progressively to the apex where it was maximum, equaling one third the thickness of the periphery. Brailey,[44] reporting on a trephine button removed from the apex of a cone, found Bowman's membrane intact. Salzmann,[45] in another case, found a thinning of Bowman's membrane with many gaps of continuity under which was a stratum of crowded, elongated, clublike nuclei. Beneath these the normal lamellae were replaced by a web of caudate and nuclear fibers. The gaps in Bowman's membrane were filled with a peculiar connective tissue different from normal corneal stroma and containing "elastoid" fibers resembling those found in a pinguecula. Some of the fibers passed in front of and some behind Bowman's membrane. Deeper layers of the stroma at the apex showed some tendency to split, with the formation of lacunae longer than those in normal stroma. A considerable gap in Descemet's membrane was noted in the region of the ectasia.

A. Vogt,[46] reporting on two eyes examined, was impressed by "an equal sized wave formation of the parenchymal lamellae. In the first case this was present only in the posterior part but in the later case this condition was present through the entire thickness."

Fig. 5 (Terry and Chisholm). Case 1, O.D. Keratoconus of 52 years' duration in patient with hereditary syphilis and luetic chorioretinitis. The keratoconus in each eye was operated on once in an attempt to relieve the irritation produced by the extreme deformity.

The Fleischer ring, so impressive by slitlamp examination, appears not to have been observed in any pathological specimen of conical cornea.

A study of available pathological material is disappointing because some complication in each case not only may hide important features of the disease, but also may be greatly responsible for many of the findings.

Case 1. Mr. J. M., 70 years of age, with old hereditary syphilitic chorioretinitis, mature cataracts, amaurosis, and conical cornea of 52 years' duration, was operated on to reduce the keratoconus. The patient stated that a diag-

nosis of paralysis of the optic nerve had been made many pears previously. Because the operation did not reduce the conicity of the cornea sufficiently to relieve the patient from discomfort incident to the extreme height of the cones, he requested that the eyes be removed. A bilateral enucleation was performed on June 5, 1920. To quote from the record preceding the operation, "both eyes are conical, extending forward in cone shape about 5 mm. higher than normal. Leukoma at apex."

One might discount the hereditary syphilis, with unmistakable luetic chorioretinitis, as a cause of the keratoconus, since interstitial keratitis should thicken and add to the strength of the cornea, but the eyes had been operated on, and the pathological picture could be only that of the late sequelae of keratoconus. Igersheimer[17] reported one instance of conical cornea following insterstitial keratitis.

The conicity of the cornea was limited to the middle two thirds of the cornea, the cone in each eye being quite high. The thickness of the sclera just behind the limbus was 0.84 mm. in the right eye and 0.80 mm. in the left eye, while the thickness of the cornea at the edge of Bowman's membrane was 0.68 mm. in the right eye and 0.76 mm. in the left eye (figs. 5 and 6). At the base of the cone, the width decreased to 0.2 and 0.32 mm. in the right and left eyes, respectively. The measurements were made on the microscopic sections and because of shrinkage incident to preparation of the sections can be considered of only relative value.

At the periphery of the cornea the substantia propria stained well. It was infiltrated moderately with lymphocytes and plasma cells, and a few small blood vessels were present. However, the fibers of the corneal stroma were wavy like those observed in Salzmann's case. The staining grew fainter at the base of the cone, and in the cone itself, in addition to the great reduction in the number of lamellae, the fibers appeared hyaline. Very few corneal corpuscles and wandering cells were present. In the central portion of the cone Bowman's membrane was absent over a relatively wide area, and the epithelium in this region showed a mild edema. Descemet's membrane was also absent in the central portion of the cone over a much shorter area. The corneal endothelium was largely absent. No pigment was observed in Bowman's membrane suggestive of a Fleischer ring. There was little difference between the two eyes.

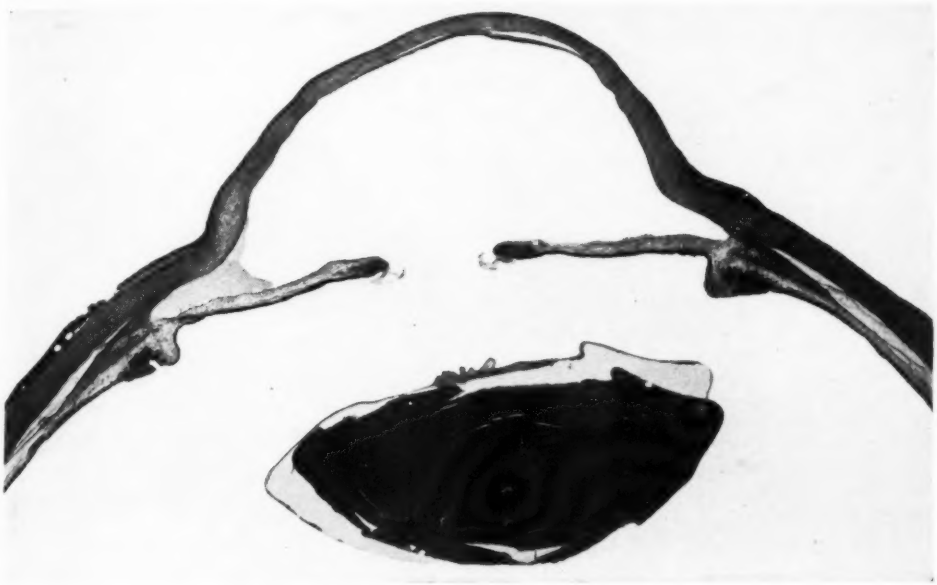

Fig. 6 (Terry and Chisholm). Case 1, O.S. See legend for figure 5.

Sections of the following cases were obtained for study from the American Registry of Pathology and it is through the courtesy of the Registry as well as of Dr. Edward C. Ellett, Dr. M. I. Ostrom, and Dr. John L. Montgomery that a report of these cases is included.

Case 2. American Registry #41894. A 53-

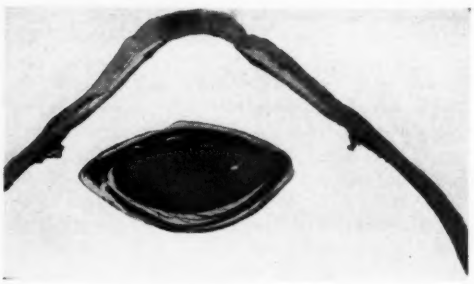

Fig. 7 (Terry and Chisholm). Case 2. Keratoconus of 18 years' duration. The cone had been cauterized after the deformity developed. Note anterior synechia and exuberance of scar-tissue formation, making the region in which the cone had existed thicker than normal.

year-old man had keratoconus known to be present for 18 years. One year after the cone developed, cautery was applied to the apex of the cone and on the cornea downwardly and outwardly. A contact glass was tried one year before the enucleation but could not be worn because of the height of the cone. At the time of enucleation a large anterior staphyloma, corneal scar, vascularization, iris adherent to cornea, flat anterior chamber, and increased tension were noted. Keratoconus was also present in the other eye.

The cornea in microscopic section was grossly cone shaped, but the center of the cone was thicker than any other part of the cornea, appearing to be an exuberant repair of a relatively recent perforation of the cornea with adherence of the iris (fig. 7). No changes specifically characteristic of conical cornea as reported by Salzmann or observed in case 1 were noted.

Case 3. American Registry #54278. The sections were from the eye of a 21-year-old man who had had iridocyclitis and corneal ulcers 20 years previously. One month before the enucleation the eye became painful. At the time of enucleation findings of corneal ulcer, atrophic and adherent iris, cataract, and glaucoma were noted. The other eye showed no clinical evidence of keratoconus.

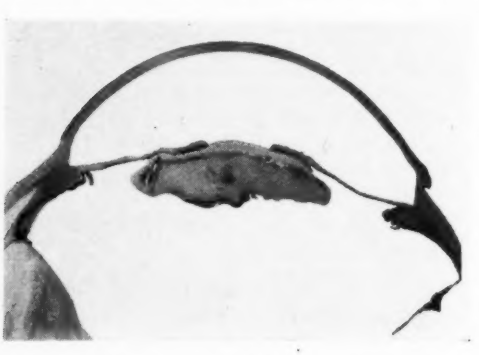

Fig. 8 (Terry and Chisholm). Case 3. Corneal deformity resembling keratoglobus more than keratoconus. The other eye showed no corneal deformity.

The cornea in microscopic section appeared diffusely stretched, resembling more the appearance of keratoglobus (fig. 8). The cornea was thicker centrally than at its pheriphery where marginal ectasias were present. This specimen likewise had no findings resembling those of Salzmann's case or of case 1.

Case 4. American Registry #58870. The sections were from the left eye of a 54-year-old man who gave a history of measles having settled in this eye 43 years previously. There was no evidence of keratoconus in the right eye.

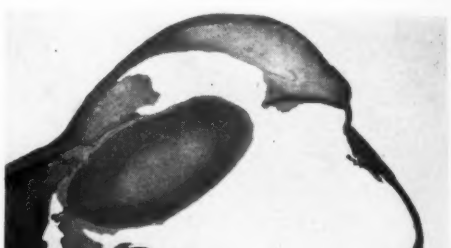

Fig. 9 (Terry and Chisholm). Case 4. Unilateral keratoconus complicated by glaucoma, rupture of the cornea, and intraocular infection.

Preceding enucleation the clinical findings were glaucoma, keratoconus, ruptured anterior chamber, cloudy cornea, and intraocular infection following the rupture. Four weeks after the perforation the eye was enucleated. In spite of the adherence of the iris and the organization of exudate on the back of the cornea, in one place changes of the type described by Salzmann and in case 1 were still evident (fig. 9).

Since conical cornea in itself rarely leads to a sequence of events likely to be treated by enucleation, paucity of pathological material even of well-developed keratoconus is not surprising.

That the posterior one half or two thirds of the normal cornea has sufficient strength to prevent development of an ectasia is shown by the failure of any

herniation to result after a considerable portion of the cornea has been stripped off in the treatment of bullous keratitis, lattice keratitis, and allied conditions.[48]

It appears that the lamellae lose or tear their connections, becoming partially disjoined, thereby giving rise to keratoconus. Because this occurrence appears to give rise to little stimulus for repair, the weakened conical cornea is more likely to increase by relatively imperceptible stages or by sudden great steps, depending on the amount and length of time that intraocular pressure is increased to an extent larger than the weakened cornea can tolerate. It is important to remember that no lamellae reach entirely across the cornea. Therefore any overdistension sufficient to disrupt the connection between the individual lamellae and adhesion of the lamellae would cause a slipping of the layers. This slipping would give rise to an ectasia of the cornea in an amount directly proportional to the amount of slipping. The development of the ectasia is free from irritative factors to such a degree that little or no stimulus for scar-tissue repair is present, which explains the development of a scar at a relatively late stage.

It is interesting to conjecture upon the possible similarity between keratoconus and hernia. Certain hernias develop after puberty or in adult life after considerable exertion. They are based on a congenital weakness. At first the deformity is usually slight but once started and not treated it results in an ever-increasing deformity with little or no attempt at repair on the part of the body tissue. Somewhat similarly, diverticulum of the esophagus may be considered.

Treatment

Pressure treatment of conical cornea has been tried for many years. The early textbooks suggest its use but do not consider the final results too hopeful.[49] Pressure treatment is considered to be an accessory treatment in many operations. Arnold Knapp[50] recommended continued pressure by means of a firm monocular bandage for 5 to 6 weeks and a continuation of the pressure during sleep for 6 weeks more following cauterization treatment.

The application of this form of treatment alone was discovered somewhat accidentally during the care of the patient in case 5, but its full value was not recognized until the patient in case 6 was being treated.

Case 5. Mr. A. F., 14 years of age, with keratoconus of one year's duration was referred to us by Dr. Herman Grossman for fitting of contact glasses. Vision of 20/30 in the right eye and 20/40 in the left eye was obtained by means of Zeiss contact glasses. The patient was very enthusiastic about the improvement of vision obtained and tended to use his contact glasses excessively. He was not entirely free from irritation while using the glasses and on his own initiative began using a drop or more of 0.5 percent pontocaine solution with the saline solution in the contact glass. The pontocaine originally was furnished to the patient to facilitate the introduction to the contact glasses.

Some 16 months later the patient developed an inflammation in the left eye. The height of the cone had increased sufficiently to press against the contact glass over a rounded area some 4 mm. in diameter. The resulting diffuse keratitis abated in two weeks upon discontinuance of the pontocaine and the contact glasses. The best vision obtainable even with contact glasses was 20/50 in the right eye and 20/70 in the left eye.

Molds of the cornea were made for the purpose of ordering a molded contact glass with a raised corneal segment. Before the order was placed the patient noticed a transient blurring of the left eye followed the next day by considerable blurring after a severe sneezing spell. Examination showed an acute increase in the amount of the cone with marked edema of the cornea. This exacerbation coincided with the arrival of a severe tropical hurricane with a precipitous drop in atmospheric pressure. The patient was hospitalized. A pressure bandage was applied to the eye over his contact glass after 2-percent pilocarpine nitrate had been instilled into the conjunctival sac. The patient was given viosterol 16 minims daily, carotine

in oil 10 minims daily, and Upjohn bone phosphate one tablet four times daily. The contact glass used as a splint was not well tolerated and was omitted after 24 hours, but the pressure was continued. The edema subsided and the height of the cone lessened. The patient was discharged from the hospital in six days. A corneal scar was present at the apex of the cone. The vision was reduced to 8/200 even though the deformity of the cornea appeared the same or a little less than that present before the acute increase.

After the rationale of prolonged pressure was worked out in case 6 (see below), pressure treatment was reapplied to the left eye some six months later. No apparent improvement was obtained. The patient did not tolerate the pressure well nor did his activities as a student in a school for the blind permit the maintenance of pressure at a satisfactorily high level. A year later the vision in each eye was 20/200 improved by pinholes to 20/70.

Fig. 10 (Terry and Chisholm). Case 6. Molds of cornea. a. Previous to ordering contact glasses. b. Within 24 hours following acute ectasia. c. After eight days' pressure treatment. Note folds of cornea. d. After seven weeks of pressure treatment.

Case 6. Miss LaP., a 19-year-old student nurse, was referred to us for fitting of a contact glass in September, 1938. Two years previously glasses had been fitted by a neighborhood optician who obtained 20/25 vision in each eye. Seven months before the patient was seen by us, a severe dermatitis developed, involving her neck and arms. This attack was attributed to the starch in her uniforms, since the dermatitis disappeared when the patient was affiliating with another hospital. Two months after the advent of the dermatitis some deterioration of vision was noted. Four months after the dermatitis started the vision had dropped to 20/130 in the right eye and 20/67 in the left eye. At this time a diagnosis of keratoconus was made.

On our first examination of the patient the vision was 5/200 in the right eye and 20/50 in the left. Although the deformity in the two eyes was somewhat similar, characterized by a marked increase in the conicity over a small central area, the deformity and thinning were greater in the right eye (fig. 10a). A mold of each cornea preliminary to ordering contact glasses showed dimpling of the right apex from the pressure of the molding alone. Because of the dermatitis, and a premature aging and obesity, especially evident in the buttocks and thighs, a thorough physical examination was requested.

The general examination demonstrated that the heart and lungs were normal. The blood pressure was 130/70. The dermatitis was characterized by a dry, erythematous appearance associated with scales and crustings. At this time the face, neck, and flexor surfaces of the arms were involved. The urine was normal. The blood count was WBC 6,900, RBC 4,500,000, and Hgb. 93 percent. A differential blood smear showed polymorphonuclears 55 percent, lymphocytes 35 percent, monocytes 4 percent, eosinophiles 6 percent, and platelets 121,000. The bleeding time was 3¼ minutes. The nonprotein nitrogen was 40 mg. percent. Glucose tolerance test: fasting blood sugar 80 mg. percent; blood sugar, first half hour after giving glucose by mouth, 182 mg. percent, after one hour 91 mg. percent, and after two hours 111 mg. percent. All urines during the test were

negative for sugar. Fasting blood calcium on three occasions was 6.1 mg. percent, 7.0 mg. percent, and 9.4 mg. percent. Fasting blood phosphate on three occasions was 3.6 mg. percent, 6.6 mg. percent and 3.8 mg. percent. Blood cholesterol on two occasions was 184 mg. percent and 178 mg. percent. Phosphatase on one occasion was 7 Bodanski units. The blood Hinton test was negative. The basal metabolic rate on two occasions was +4 percent and +1 percent. Intravenous pyelograms were normal as were X-ray studies of the humeri and tibiae. A lateral X-ray film of the skull showed the sella turcica to be of normal size and shape. Eighty-nine skin scratch tests were also negative. Examination showed only persistent low blood calcium, but there was suspicion of pituitary disease based on the distribution of fat.

The local physician placed the patient on a calcium-free diet for four days. On the fifth day there was a tremendous increase in the size of the right cone, at which time the patient was admitted to the Massachusetts Eye and Ear Infirmary. Marked edema of the right cone was present, but the deformity was considerably more outstanding than the edema. A mold of the cornea was made (fig. 10b). A pressure bandage was applied after 2-percent pilocarpine had been instilled and bed rest was ordered. In 48 hours the cone was reduced, and the curve of the cornea appeared more nearly normal than when we first saw the patient. Numerous small wrinkles were present in the cone (fig. 10c). They were arranged more or less radially but did not reach quite to the center of the cone. However, in three hours the conicity had returned. The pressure was reapplied. It occurred to one of us (T. L. T.) that the pressure should be continued until scar-tissue growth to repair the injury developed sufficient strength to maintain the normal shape of the cornea.

After receiving a report from the local medical doctor and learning of the low-calcium diet at this time, we placed the patient on a high-calcium diet with vitamins A and D. A check of the blood chemistry at this time showed NPN 22 mg. percent, uric acid 4 mg. percent, protein 6.4 percent, calcium 10.2 mg. percent, phosphorus 3.4 mg. percent, and cholesterol 89 mg. percent.

After 16 days hospitalization with continuous pressure, interrupted only for examination, the patient was discharged from the hospital. She reported at sufficiently frequent intervals for us to determine that the pressure was continuing to keep the deformity of the cornea reduced. It was evident that the cornea was thicker in the central portion and that a central scar was developing.

Three weeks after the first application of the pressure the dressing was left off in order to test whether or not the scar was strong enough to maintain the normal shape of the cornea. It was evident in 1½ hours that the keratoconus was recurring. The pressure was reapplied and continued another week after which the deformity of the cornea again became evident.

At weekly intervals further tests were made. After 10 weeks of the pressure treatment, the keratoconus did not recur with release of pressure (fig. 10d). The corneal scar had increased so that all of the pupillary area was covered. The eye appeared moderately congested through the treatment but no ocular complications were noted. There was a recurrence of the dermatitis, which was so severe that the patient was again hospitalized by the dermatology department of the Massachusetts General Hospital. At this time the vision had improved in the right eye to 18/200. The skin disturbance was diagnosed as an atopic dermatitis.

The improvement in vision and the cure of the keratoconus in the right eye prompted us to apply the same treatment to the left eye, but in four days little reduction in the cone had been obtained and no production of a central corneal opacity appeared. After reviewing various methods available to produce an irritation of the apex of the conical deformity in order to encourage a tendency for repair, we decided to cauterize the center of the cone by means of diathermy. The cauterization did not reduce the deformity at the time of operation and actual cautery was applied with moderate reduction in the cone. The pressure bandage was reapplied and continued. There was a relatively small amount of reaction to the cauterization but 18 days after the operation the cornea perforated. The anterior chamber reformed in 24 hours after omission of the pressure. As the deformity did not increase materially the pressure was not reapplied until nine days after the perforation. Twenty-two days after the second application of pressure vascularization of the cornea was noticed, blood-vessel loops having extended about 3 mm. from the limbus at the 5-o'clock position. Some eight weeks after the first application to the left eye it was found that the corneal deformity did not increase when the bandage was omitted. Although upon removal of the pressure bandage the vision was only 10/200 in the left eye, 11 days later, as infiltration disappeared and scar tissue began to contract, the vision had improved to 20/70.

Further decrease in the corneal opacities has continued up to the present time. The patient, 1½ years after the acute exacerbation, obtains practical vision of 20/50 in each eye with glasses, is continuing her school work, and is happy in what she considers to be a complete and satisfactory cure.

Case 7. Mr. J. F. B., 26 years of age, was first examined by us in March, 1939. He had keratoconus of two years' duration. The vision in the right eye was 20/30—2 and in the left eye was 20/200. By means of a Zeiss contact glass 20/15 vision was obtained in the right eye and 20/30 in the left eye. The keratoconus was mild in the right eye and moderately severe in the left. Scarring of the apex of the cone was evident. The left cone was so thin at its apex that it dimpled when a mold of the cornea was made. A pressure bandage was applied, and in 24 hours considerable wrinkling of the cornea was present. Although the patient complained of considerable pain, he tolerated the pressure well. In three days the opacity in the center of the cone had increased, presumably from wrinkling, edema, and infiltration with wandering cells, since the short interval of time would make scar formation impossible.

At the end of the first week, the circumcorneal region showed considerable hyperemia, both superficial and deep. The cone was decidedly reduced, but the relief of the pressure for even one-half hour resulted in the recurrence of the deformity. After the pressure had been continued for one month, the eye appeared deeper in the orbit, a real enophthalmos having been produced.

At the end of six weeks of pressure, a deep vascularization of the cornea was present especially on the temporal side. The pressure treatment was discontinued because of this complication. The scarring of the cornea, however, was strong enough to prevent a recurrence of the corneal deformity. The progress of the patient was followed closely for another month, during which time the blood vessels in the cornea became obliterated. The vision was 20/200 but with the spontaneous reduction in the size and density of the scar one year later the vision in the left eye was 20/50 with a —1.50 D. cylinder, improved by means of a pinhole to 20/30.

On May 14, 1940, the right eye suddenly "went blind." Upon examination the following

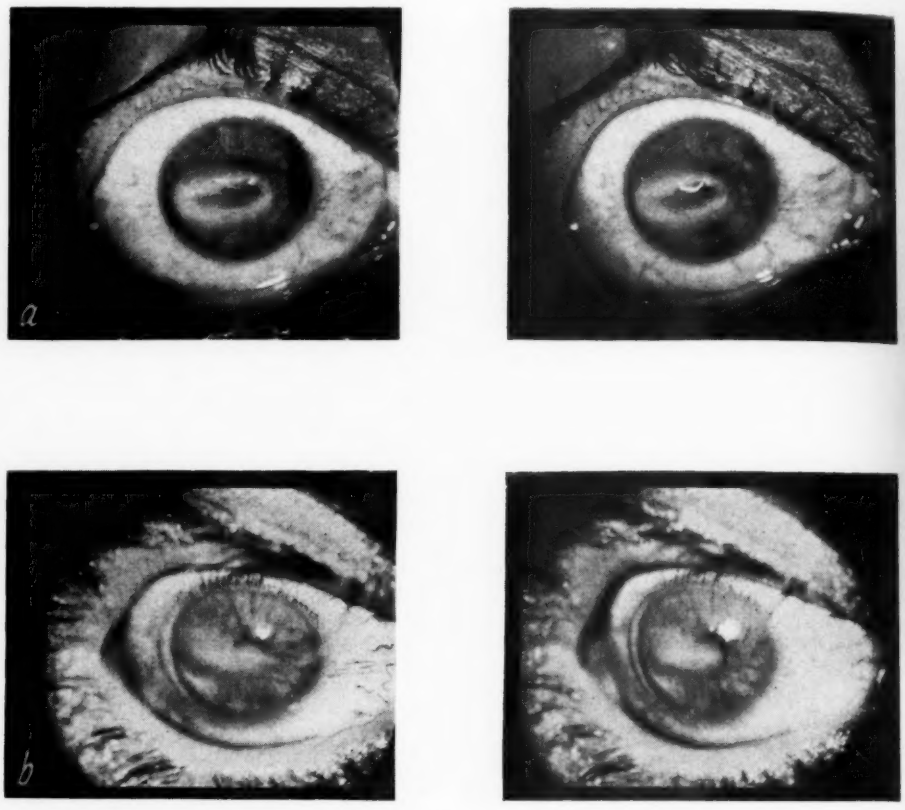

Fig. 11 (Terry and Chisholm). Case 7. Stereophotographs of cornea. a. Eighteen hours after sudden increase in corneal deformity. b. After two weeks' pressure treatment.

morning, the cause of the sudden "blindness" was found to be a rupture of Descemet's membrane and the posterior layers of the stroma with considerable corneal edema, the condition which Rychener and Kirby[31] call acute hydrops of the cornea. The herniation of the cornea was not conical but ridge-shaped, having a horizontal extent much smaller but roughly corresponding to the exposure area of the cornea (fig. 11a). The central portion of the deformity was extremely thin, and mild pressure applied through the lid would distort not until after 72 hours that the proper technique for applying sufficient pressure was worked out, and 24 hours after the satisfactory dressing was devised, the corneal deformity was reduced, only to return in part even with the pressure relieved for 10 minutes. Ciliary injection developed and the pupil was miotic. There was no other evidence of iritis, however. The pupil dilated readily with atropine.

Insufficient time has elapsed to state with certainty that the deformity has been cured, but at the present time the ectasia has been

Fig. 12 (Terry and Chisholm). Case 7. Molds of cornea. a. Within 24 hours following acute ectasia. b. After three days' pressure treatment. c. After 10 days' pressure treatment. d. After two weeks' pressure treatment.

the entire region. The patient was carefully questioned as to any condition which may have raised the eye pressure or general venous pressure. Although at first he could not account for the sudden exacerbation of the deformity, repeated questioning finally revealed that the patient had noticed some mild irritation of the eye relievable by massage with moderate pressure. The patient had massaged his eye less than a minute before the vision suddenly failed. He was asked to demonstrate the amount and duration of the massage by applying his finger to a small letter scales. The pressure was 1¼ pounds and lasted only eight seconds.

After the cornea was molded (fig. 12a) the pressure treatment was started. The bandage did not hold well and in 24 hours the corneal deformity was only partially reduced. It was almost completely reduced* (figs. 11b, and 12b, c, and d).

Case 8. Mr. G. L. F., 47 years of age, was first examined by us in June, 1934, at which time he had a small amount of keratoconus in each eye, but obtained 20/30 and 20/20 vision in the right and left eye with a concave sphere and a 2-diopter concave cylinder; glasses, however, had not been comfortable nor fully satisfactory. As a master in a boys' school in charge of athletics, he was anxious to have contact glasses fitted. The contact glasses served him

* On July 30, 1940, the pressure was discontinued for 6 weeks. On Sept. 6, 1940 examination of the right eye showed a slight facet in the center of the scar. The corneal vessels were still filled with blood. Corrected vision for the right eye was 20/70 + 2 and for the left eye 20/30.

moderately well, and the patient increased the time of wearing the glasses from the prescribed 6 hours daily to 12 or 15 hours.

In five years a vascularization of the cornea developed, extending some 2 mm. from the limbus. The conicity of the cornea in each eye had increased, and scarring of the apex of each cone was present. The patient was instructed to discontinue the use of contact glasses.

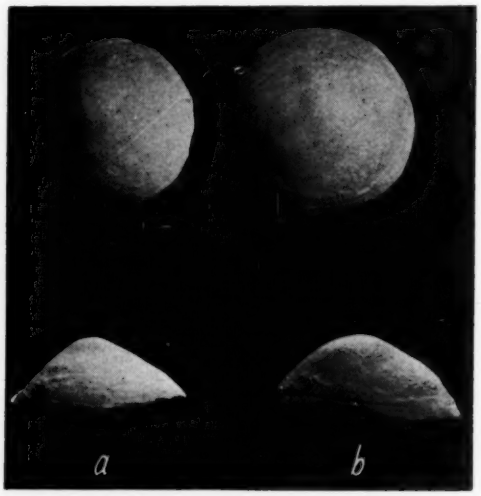

Fig. 13 (Terry and Chisholm). Case 13. Molds of cornea. a. Before pressure treatment. b. After eight weeks' pressure treatment.

Pressure treatment was started, but the vascularization of the cornea increased slightly within one week. The eye showed considerable circumcorneal injection. The pressure was continued for six weeks, however, at which time the vascularization had increased to such an extent that pressure treatment was discontinued. The patient derived no real benefit from the treatment.

Case 9. Mr. A. K., 17 years of age, with bilateral keratoconus of 1½ years' duration had vision of only 20/200 in each eye with glasses when first examined at the Massachusetts Eye and Ear Infirmary, in 1937.

Two years later his left eye became irritated, and while attending a cinema, the patient rubbed the eye. Following this massage the vision decreased. Examination revealed a definite increase in the deformity, with scar formation and moderate corneal edema. The pressure treatment was started, and in 24 hours the deformity was reduced and the corneal edema had abated. In three days moderate hyperemia of the conjunctiva and a mild conjunctival edema were present. At the end of three weeks the patient would not continue the pressure treatment. His vision was 4/200.

Case 10. Mrs. P. M., 31 years of age, was first examined by us in May, 1939, because of irritation and photophobia of the right eye. Bilateral keratoconus was present. The deformity of the left cornea was slight, and the patient obtained 20/20—2 vision with a contact glass; but the deformity of the right cornea was so prominent that the lids could not be closed completely. Considerable scarring at the apex of the cone was present. The vision in the right eye was 20/200. After the cornea was molded, pressure treatment was started in the right eye. In five days considerable ciliary injection was present. Atropine was used with each application of the pressure. In one week considerable reduction in the ectasia and wrinkling of the abnormal portion of the cornea were evident. In four weeks material increase in the scar had occurred. In six weeks numerous folds in Descemet's membrane were evident.

Leaving the pressure off for one hour after eight weeks' treatment gave rise to an increase in the deformity. Repeating this test at intervals, it was 13 weeks before the pressure could be omitted without an increase in the deformity. Although the deformity was not completely reduced by the treatment, the patient was able to close her lids, the eye appeared relatively normal, and the vision improved.

Case 11 Mr. F. S., 25 years of age, first examined by us in October, 1933, had bilateral keratoconus with 20/40 vision in each eye with contact glasses. Slight scarring was present at the apex of each cone. He wore contact glasses with relative comfort for six hours at a time. The toleration for contact glasses became less, and the patient was able to wear them for only three-hour periods.

Pressure treatment was started on the right eye in September, 1939, but in 24 hours erosion of the apex of the cone appeared. Continued application of the pressure did reduce the deformity and produce wrinkling of the cornea. The staining area increased in size, because of which the pressure was discontinued for one week until the cornea was healed. Reapplication of the pressure caused another erosion to develop, and treatment was given up.

Case 12. Mrs. S. DeL., 28 years of age, was first examined by us in April, 1938. She had well-developed keratoconus with scarring of the apex of the cone in each eye. Her vision was 3/200 in the right eye and 10/100 in the left eye. Healed trachoma involving each eye had left a pannus in each cornea.

The patient did not tolerate a contact glass well. During the trial period she developed epithelial dystrophy and extreme photophobia. She was given cod-liver oil and Mead Johnson

Mineral Mixture Tablets No. 85, in accordance with the suggestion of Arthur A. Knapp.[24] The photophobia and epithelial dystrophy abated.

In February, 1939, pressure treatment was started on the right eye but the patient had so much discomfort that she removed the dressing. Not only did erosions develop at the apex of the cone but the pannus increased. Three attempts were made to continue the treatment, but the patient found it intolerable.

Case 13. Miss R. T., 39 years of age, with keratoconus well developed in each eye and scarring of the apex of the cone, was first examined by us in 1938. She was fitted with a contact glass which she tolerated on her right eye for six hours a day. Her vision was 20/50 in the right eye and 20/40 in the left.

She was again seen in March, 1940, and during the period of time since her last examination the deformity in the right eye had increased considerably, so that the central portion of the cornea pressed against the contact glass over an area of 3 mm. She discontinued the use of the contact glass, and the pressure treatment was started (fig. 13). In one day the cone was somewhat reduced, and wrinkling of the cornea developed. Not until pressure had been applied for 10 days was the deformity greatly reduced. This patient had extremely tender skin, and the pressure bandage alone excoriated the epithelium from the forehead and the lobe of the right ear. The patient's sister, a graduate nurse, suggested the use of sheet wadding around the head to protect the skin from the relatively rough pressure bandage.

The patient developed considerable congestion of the bulbar conjunctiva and miosis of the pupil, which were considered to be evidence of a mild iritis, a condition observed in other patients under pressure treatment to a considerably less extent. The pupil dilated sluggishly or not at all, however, when atropine was instilled, even though no synechiae were discernible. No cells were seen in the anterior chamber, no evidence of iris hyperemia was present, and there was some slight pupillary response to light even in the tonic pupil. A solution of 2-percent epinephrin readily dilated the pupil. It must be remembered that the patient had considerable scarring of the cornea and fine details were not easily seen with the slitlamp.

Because of the miotic pupil the pressure was omitted for 24 hours after it had been applied for four weeks. As the diagnosis of iritis became untenable and fear of this complication abated, the pressure was reapplied. The deformity which had partially recurred was again reduced considerably and the miosis and ciliary injection were only moderate.*

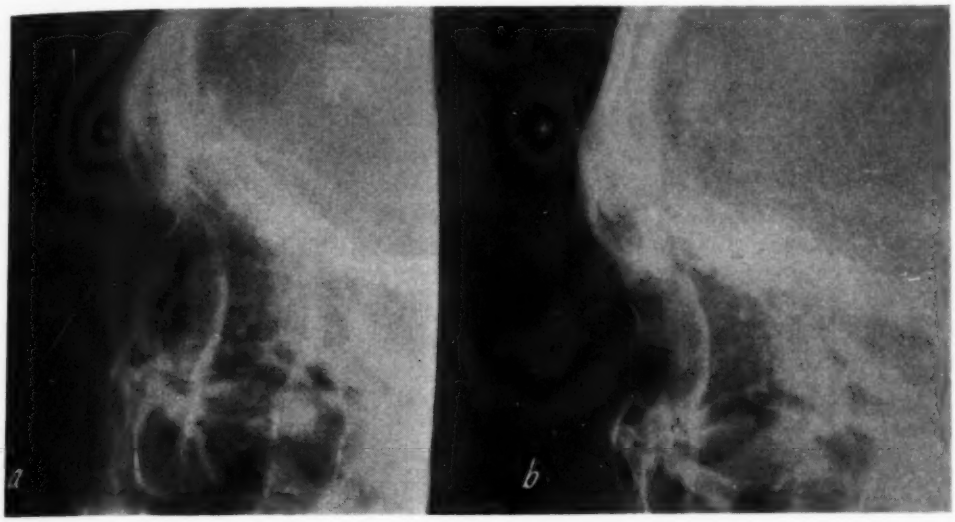

Fig. 14 (Terry and Chisholm). X-ray film proving that the eye rotates freely under a pressure bandage. The position of a needle inserted into the conjunctiva near the limbus changed considerably when patient with pressure bandage applied to the eye fixed unbandaged eye (a) up and (b) down.

* The pressure was discontinued on July 10, 1940. Six weeks later the cornea appeared of normal curve, the central scar was less, and the vision was 20/30.

Discussion

These studies (table 1) show that the deformity of the cornea in keratoconus can be cured in certain instances by means of pressure. The pressure must be applied long enough for the scar-tissue growth, stimulated by the treatment, to mature sufficiently to support the abnormally weak cornea. The application of the pressure bandage acts as a truss which temporarily flattens the cornea so long as the eye is directed more or less straight ahead. The pressure bandage does not immobilize the eye.* Rotating the eye even slightly would shift the position of the cornea under the pressure sufficiently to cause the wrinkling and folding of the cone to change its pattern. This change may be enough trauma in itself to produce an irritation sufficient in amount to stimulate fibrosis to occur. Since the eye can rotate relatively freely while the pressure treatment is being applied, those who rotate their eyes upward during sleep have shifted the cone and even the cornea itself away from the region in which the pressure is effective. Such a situation might tend to increase rather than decrease the keratoconus during sleep, which may explain some of the failures of the treatment to reduce the corneal deformity. Thus it may be wiser to omit pressure during sleep.

In eyes with abnormally low pressure, usually the result of some extensive and

TABLE 1

Summary of results of pressure treatment in nine cases

Cases	Age	Sex	Duration Keratoconus Years	Vision R / L	Duration Pressure in Weeks	Erosion	Ciliary Injection	Tonic Pupil	Amount of Flattening	When Flattening Appeared Days	Vascularization	Vision After Pressure	Vision at Follow-up	Remarks
5	15½	M	2½		6 days	0.			+++	2		8/200	20/200	Probably better results in original Treatment had the need for prolonged Rx been realized.
6	19	F	1	R 5/200 / L 5/200	10	Op→ Part	+++		+++	3	++	18/200 / 10/200	Glasses 20/50 / +20/50+2	Excellent results
7	26	M	3 / 2	R Shadows / L 20/200	3 / 7	− / 0	+++ / ++++	0 / +	++	7	0 / +++	20/200	20/50	Treatment not yet complete but results satisfactory at present time. Excellent visual results.
8	47	M	5	Z contact glass 20/30	6	0	++				+		Z contact glass 20/30	Treatment discontinued. Developed insufficient scarring while vascularization increased.
9	17	M	3½	4/200	3	0	++++		+	1		4/200		Patient refused To continue Treatment.
10	31	F		R 20/200 / L 20/20	15	0	++++	++	+++	7	++	20/200	20/200 / 20/20	Excellent cosmetic result. Irritation completely relieved. Normal vision left eye.
11	25	M	6+		2−	+	++++	++	0		0			Treatment discontinued because of recurring erosion of cornea.
12	26	F	2+	3/200	± 2	+	++++	+++			+	3/200 / 10/200		Old Trachoma and pannus present. Poor subject for Treatment. Discontinued when pannus increased
13	39	F		R Z contact glass 20/70 / L Z contact glass 20/50	10	−	+++	++			0	Materially Improved		Treatment not complete but results most satisfactory To date.

* A small needle was inserted under the conjunctiva just temporal to the limbus on one of us (J. F. C., Jr.), a pressure bandage was applied, and X-ray films exposed when the gaze was directed up and down. The X-ray film showed that the needle moved considerably, proving that the eye rotated relatively freely in spite of the pressure (fig. 14).

destructive pathological process, phthisis bulbi almost invariably follows. As the eye, normally inflated with vitreous, crystalline lens, and intraocular fluids to a pressure of 16 to 25 mm. of mercury, loses some of its contents and pressure, the sclera and the cornea contract and become thicker, often reaching 2.5 mm. in thickness. The reduction in the deformity and the increase in the thickness of the cornea following prolonged pressure treatment may be analogous to the same changes in phthisis bulbi. In other words, there is a normal tendency for cornea and sclera to shrink because of the resiliency of these structures when relieved of intraocular pressure directly by hypotonus or relatively by application of pressure bandage.* If this is the true explanation, then this treatment should be applicable also for the reduction of progressive myopia and of scleral ectasias. Attempts to study the effect of prolonged pressure on the normal cornea of laboratory animals have proved completely unsuccessful because thus far no satisfactory method has been devised to apply and maintain the pressure.

It is possible that further study will demonstrate that the success of the pressure treatment depends on factors not now obvious. It is axiomatic that the treatment would produce a scar or increase the size of a scar already present in the cornea if the permanent success of the treatment depends, as it seems to depend, on the production of scar tissue. The size and density of the scar are surprisingly small some weeks or months after the treatment is completed. The amount, in general, appears to be less than that obtained from cauterization of the apex of the cone. Because the scar is a necessary sequela, one should not contemplate the application of the pressure treament in keratoconus where no scar is present, and when the patient obtains a minimum of 20/40 vision with ordinary glasses or with contact glasses.

The increase in the thickness of the cornea to normal which results from successful pressure treatment should facilitate corneal transplantation.

Pagenstecher[23] explained the mydriasis usually observed in association with keratoconus on the basis of the magnification incident to the optical effect of keratoconus. He showed that the apparent mydriasis and the anisocoria disappeared when the optical effect of the cornea was temporarily effaced by submerging the eyes under water. The ciliary injection and the miosis, almost invariably present after several days of pressure treatment, interpreted at first to be an anterior uveitis, gave no trouble in most of the cases, the pupil dilating readily with atropine. Slitlamp studies showed no hyperemia of iris vessels, no synechia, and no cells in the anterior chamber; but it must be remembered that the corneae were scarred, wrinkled, and in some cases edematous, making precise slitlamp observations impossible. In case 13 the miosis and ciliary injection were extreme. The pupil did not dilate after instillation of atropine. The pupil, although small, did react slightly to light. Mydriasis was obtained promptly and fully when 2-percent epinephrin was instilled. Interpretation of this tonic pupil is difficult. Cogan** suggested that the effect may follow extreme passive congestion of the uvea as a direct effect of the pressure treatment. This assumption is based on the miosis produced in rabbits following experimental

* A sphygmomanometer bladder, folded and slightly filled with air, was enclosed in the pressure dressing. The reading on the certified Tycos dial indicated that the pressure applied to the eye by the dressing was from 30 to 40 mm. of mercury.

** Cogan, D. G.: Personal communication.

a
b
c
d
e
f

obliteration of the vortex veins which precedes the advent of glaucoma. No immediate nor remote evidence of temporary increased intraocular pressure or glaucoma was observed after the pressure bandage was removed. All of the eyes were soft to palpation. In cases 7 and 13, temporary enophthalmos was produced. In fact the tension measured immediately after the application of a pressure bandage for 15 minutes on the right eye of a person with normal eyes gave a reading of 8 mm. in the right and 16 mm. in the left eye (new Schiötz tonometer).

Wrinkling of the cornea, actual or apparent, disappeared in two to three weeks even when the pressure was continued. Wrinkles in some cases involved the anterior or the posterior surface of the cornea, while in others striae, resembling wrinkles, actually represented some temporary intracorneal linear opacities. The wrinkles invariably radiated from near the center of the cone. Usually they were of relatively uniform length and position.

Vascularization of the cornea appeared to be relatively frequent, but fortunately not far from the limbus. Lack of oxygen supplied from the air or from tears; increased metabolism incident to the scar-tissue growth; increased pressure on the cornea retarding the normal passage of food, oxygen, and waste products; or a combination of these factors may account for the tendency to blood-vessel growth into the cornea. If this complication gave evidence of penetrating near the center of the cornea, the pressure could be omitted for short periods of time daily or a peritomy could be performed if the region of the vessel ingrowth was relatively localized. Except in the event that a corneal transplantation might be desired ultimately to rid the patient of the central scar, vascularization of the cornea relatively near the pupillary area need not give ultimately poor results. In fact many surgeons have advocated not only cauterizing the apex of the cone but also cauterizing a tract from the apex to the limbus for the purpose of stimulating blood-vessel invasion of the cornea.

Erosion, noted in some cases, did not

Fig. 15 (Terry and Chisholm). Series of illustrations showing technique of applying pressure bandage. Pressure is to be applied to the left eye. The following equipment is needed: 1. Strip of gauze bandage about a yard long. 2. Strip of 3-inch sheet wadding long enough to go around the head twice. 3. Strip of 0.5-inch adhesive about 5 inches long. 4. A piece of absorbent cotton weighing about 0.5 ounce. The cotton is folded from the edges into an elongated shape, larger but conforming to the external orbital opening. The smooth side of the folded cotton is placed against the eye. 5. A 2.5-inch Bender bandage.

a. The gauze bandage is placed over the head with a fold pinned over the left ear to allow extra length. A small quantity of boric ointment is then applied to the lid margin of the left eye.

b. The sheet wadding is wound around the head. One end of the strip of adhesive is stuck against the center of the sheet wadding above the right eye and the strip is allowed to hang over the eye with adhesive side out. The piece of cotton is placed against the eye and held in place by the patient.

c. The application of the pressure bandage is started just above the right ear, carrying the bandage around the back of the head, above the left ear, firmly across the forehead, and again above the right ear. The next turn about the head is carried below the left ear and obliquely up over the left eye, so that the cotton is firmly pressed against the eye. This turn is anchored by another turn around the head above both ears. Alternately, the bandage is carried around the head below the left ear and obliquely over the left eye, and above both ears, until at least three layers of bandage cross the left eye obliquely and four layers go around the head above both ears. The end of the bandage is fastened firmly and the free piece of adhesive hanging down in front of the right eye is lifted up, pulling the dressing up above the eye. The gauze bandage is cut in two places: (1) at the top of the head, and (2) in the center of the fold over the left ear.

d. and e. The three strips of gauze bandage are tied to gather the pressure bandage away from the ears and at the same time tighten it.

f. The patient makes the dressing much less obvious by covering the head with a scarf.

prove to be of serious consequence. It may result from pressure atrophy or lack of nutrition. If no secondary infection arises, the erosion may be of benefit in stimulating a more vigorous scar-tissue repair. This complication should not lead to discontinuance of the treatment.

The technique of application of the treatment gradually evolved and is given in figure 15. The technique is given in detail because several less-effective methods of applying a pressure bandage appear in general use. The bandage is changed daily for one week after which time the intervals between dressings may vary from two to four days. Some patients with the help of friends learn to change their own dressings, reporting at intervals of seven days for check-up on the ocular conditions. At various intervals molds of the cornea show just what progress is made. If there is no definite reduction in the amount of the corneal deformity in 7 to 10 days, there appears to be little hope of obtaining any beneficial results. Omitting the pressure, perhaps because of complications, delays the attainment of desirable results, but if the interruption is not too long the primary beneficial result is not entirely lost.

This report is given as a study of the effect of pressure on the eye, not as a treatment to be advocated for all individuals who have keratoconus. Many variations in the technique of treatment must be investigated; such as, omission of the dressing at night and the development of some simple, easily adjustable, less unsightly truss to maintain the pressure, thus avoiding the cumbersome and uncomfortable pressure bandage.* The value of prophylactic treatment in mild keratoconus also should be determined.

The number of cases reported is necessarily small because keratoconus, advanced sufficiently to warrant the severe, unpleasant, disfiguring treatment, is relatively rare. Pressure treatment is advocated for those patients who have had acute increase in the amount of conical cornea, who are unable to close their lids, and who cannot wear contact glasses, especially if the glass does not clear the cone. It is hoped that this result will stimulate others to continue the investigation.

Summary and conclusions

From our studies of keratoconus and our successful experience in applying pressure to cure the corneal deformity, the following facts should be stressed and the following conclusions drawn:

Thinness in the central area of the cornea appears in the embryo and persists through life, representing a physiological keratoconus.

The tensile strength of the cornea depends primarily on the white fibers of the substantia propria and the forces binding them together. Secondarily, elastic fibers lend strength when the cornea is distended.

If elastic tissue is an important constituent of the cornea, conditions causing elastic-tissue degeneration, such as stria gravidarium, pseudoxanthoma elasticum, pinguecular formation, and even the elaboration of relaxin during pregnancy, may be of some etiological importance in keratoconus.

The greater number of lamellae at the periphery strengthens the cornea here.

An hereditary weakness of the cornea need not manifest itself until puberty or early adult life when the eye is subjected to its greatest pressure—except during

* Since this paper was originally submitted, Pomeroy Company, 41 West Street, Boston, has designed a truss which proved more satisfactory than the pressure bandage for one patient. Modifications are still being made on the truss.

parturition—perhaps, because of the stresses of life.

Possible value of pressure treatment in progressive myopia and other scleral ectasias should be investigated.

1. The essential pathological process of keratoconus has not been observed since all pathological material studied represented late stages of the disease after complications and often after surgical treatment had altered the picture.

2. As no lamellae extend over the entire cornea, any overdistension sufficient to disrupt the connection and adhesion of the lamellae would cause a slipping of the layers, thus producing an ectasia of the cornea.

3. As determined from testing the tensile strength of corneal strips, the rabbit cornea should rupture at an internal pressure of 697 mm. of mercury.

4. The fact that small degrees of keratoconus are relatively frequent is observable upon painstaking examination of many patients with over three diopters of astigmatism, especially if one meridian of the error of refraction is myopic.

5. The development of keratoconus lacks sufficient irritation to stimulate scar-tissue formation until late in the growth of the deformity.

6. Pressure treatment, the full value of which has hitherto been unrealized, does reduce the deformity in some instances and gives permanent cure of the disease if the pressure is maintained sufficiently long (at least 10 weeks) to allow scar-tissue repair to mature enough to hold the newly attained more or less normal thickness of the cornea.

7. The eye rotates freely under the pressure bandage.

8. The cure of the corneal deformity may arise (a) through irritation and a reaction of fibrous-tissue growth brought on by almost continuous change in the pattern of folds and wrinkles of the cornea under compression incident to rotation of the eye; (b) through the normal tendency of the cornea and sclera to contract and thicken when intraocular pressure is lowered indirectly by greatly elevating the extraocular pressure by means of the pressure bandage.

9. Complications of variable importance commonly met with in pressure treatment are corneal scar (in all cases), ciliary injection, and spastic miosis during the period of treatment, vascularization of the cornea, and erosion of the cornea.

10. Since the pressure bandage is to be used for 10 weeks, it must be applied more carefully than usual to avoid skin irritation and chafing of the forehead and ears.

11. Pressure treatment at the present time should be limited to patients who have keratoconus of considerable amount with reduced visual acuity not improved materially by contact glasses.

243 Charles Street.

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Discussion

Dr. Frederick H. Verhoeff: I have a question from Dr. Arthur Alexander Knapp: "If you have tried treatment of keratoconus with the vitamin-D complex, would you please contrast the results with those of pressure therapy, stressing the early and expected late complications?"

Dr. Terry: In the more detailed report of the cases, omitted in reading the paper because of time limitations, Dr. Arthur

Knapp will see that vitamins A and D as well as calcium were prescribed for all patients following the publication of his reports. It is interesting to note that an acute ectasia with hydrops of the cornea developed in one patient (see case 7) during this therapy. In another instance (case 6) the local medical doctor directed the patient to follow a diet low in calcium when the blood-chemistry study revealed a reduced calcium content. Some five days later an acute ectasia developed. The contradictory evidence of these cases leaves quite open the question of the value of vitamins A and D and calcium, yet it is our practice to continue the treatment suggested by Dr. Knapp.

CHAIRMAN GRADLE: Dr. Olga Sitchevska wishes to ask Dr. Terry, "Have you studied the effect of the contact glass on the curvature of the cornea?"

DR. TERRY: Soon after Heine made the statement that the contact glass had a curative effect on keratoconus by splinting the cone, I had occasion to use a contact glass on two patients. At this time, early in the days of the contact glass, raised corneal segments were not available. The conicity increased in spite of the contact glass. The cones came in contact with the posterior surface of the contact glass, and in each instance the cornea became widely vascularized with the vessels entering the pupillary area.

From the experience of those two cases, I believe that we should not consider the contact glass as a good splint or truss to prevent the progress of keratoconus, much less to reduce the deformity. I do not believe that the wearing of a contact glass will have any beneficial effect in reducing keratoconus or in preventing keratoconus from increasing unless the cone is touching the glass, a condition to be avoided.

DR. JONAS S. FRIEDENWALD (Baltimore): Dr. Terry spoke of the effect of the pressure bandage as changing the balance between intraocular and extraocular pressure in the sense of producing a relative reduction of intraocular pressure.

At another point in his discussion he said that the effect that he was producing was similar to that of occluding the vortex veins and raising the intraocular pressure. I should like to know whether he has any definite evidence as to the effect of this procedure on the balance of intra- and extraocular pressure.

In connection with this, he raised the question as to miosis in these patients, and I should like to ask whether miosis that fails to respond to atropine but reacts promptly to adrenalin does not indicate a postganglionic paresis of the sympathetic.

DR. TERRY: That pressure treatment does apparently reduce intraocular pressure is based on the fact that palpation of the eye after the pressure bandage is removed shows the eye to be mushy soft in almost every instance.

In the instance where the needle was inserted into the conjunctiva to see if the eye moves freely under the pressure, the bandage was left on for a period of 15 minutes. The intraocular tension, measured by means of a Schiötz tonometer, was found to be reduced from 16 mm. Hg to 8 mm. Hg in 15 minutes. Of course, that does not mean that while the pressure bandage was on the intraocular tension was lower than normal; it does mean that after the pressure bandage was removed the intraocular tension was lower.

We actually do not know what the tension is in the eye when the pressure bandage is on. I feel reasonably sure that the pressure bandage immediately produces an increased intraocular tension. The physico-chemical mechanism responsible for the balance of intraocular tension will get rid of enough intraocular fluids for the pressure equilibrium of the

eye to reëstablish its usual balance; then when the pressure bandage is taken off, the end result is an unusually soft eye.

Obstruction of the vortex veins in the healthy rabbit eye leads to a temporary experimental glaucoma, the glaucoma disappearing when collateral circulation has been established. When the vortex veins have been tied, miosis is rather prompt, apparently a manifestation of the intense passive congestion of the entire uvea.

In a person who might already have a tendency to glaucoma, this pressure treatment might precipitate an attack, a reason why this treatment should not be entered into lightly.

Mention of the vortex veins was made because it is the only basis by which I felt I could show an analogy between this miosis which was reducible by adrenalin and not by atropine. It is possible that the miosis may be related to injury to the sympathetic nerve. I discussed that problem with Dr. Adler but he failed to be impressed with the plausibility of the theory that postganglionic paresis has anything to do with this condition; his reply made me feel that it would be of no advantage to bring this point up and to discuss it when the paper by Scheie and Adler on "The site of the disturbance of tonic pupils (Adie's syndrome)" was given last week at the meeting of the American Ophthalmological Society at Hot Springs. Sufficient data have not been collected in the cases studied for us to know all of the behavior of the sphincter and dilator pupillae muscles under various miotics and mydriatics and to solve this problem fully.

THE EFFECT OF CERTAIN PHYSICAL AND CHEMICAL STIMULI ON THE CALIBER OF THE RETINAL BLOOD VESSELS IN MAN*

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Chicago

Very little is known concerning the mechanism of spasm and physiologic constriction of the retinal blood vessels. It has been shown by Duke-Elder[1] and others that their contractility is under the control of a nervous and chemical mechanism, and that the forces which can effect such caliber changes are essentially those which control circulation. In order to study such reactions it is of the utmost importance to remember that a delicate adjustment, or equilibrium, exists between changes in the volume pressure of the vessels and the intraocular tension. When spasms occur within an established state of equilibrium, all known therapeutic measures produce a change in the level of this equilibrium, which is usually so complex that a drop in blood pressure or an increased intraocular pressure, completely overshadows vasodilatation. This has been shown clearly in the accumulated results of recent laboratory investigations on animals.

Lambert[2] in 1935 reported the first photomicrographic studies of the effect of epinephrine and nitrites in cats. His histologic studies revealed a marked decrease in the caliber of the wall of the central artery as it passed through the cribiform plate with practically no demonstrable muscle tissue in the contractile layer. In keeping with these findings, adrenalin administered intravenously in various-sized dosages produced vasodilatation in a large percentage of the animals. He accounted for this increase in the caliber of the vessels on the basis of a passive dilatation secondary to an increase in arterial tension. When nitrites were given in a series of the animals there was a narrowing of the vesssels, with changes proportional to the drop in arterial tension in all save one animal.

In 1939 I[3] confirmed this work of Lambert and published additional photographic evidence of the effect of cholines and paracentesis on the caliber of the retinal vessels. The injection of mecholyl into 20 dogs produced a decrease in the caliber of the vessels in 11, and an increase in 1. No changes were found following paracentesis.

In view of these findings, clinicians have been challenged to offer substantial proof that vasodilators, such as amyl nitrite and the cholines, actually produce an increase in the caliber of the retinal blood vessels in man. It is the purpose of this paper to present such studies made on the retinal blood vessels, and to offer photographic proof of the reactions which were observed.

Photographic methods for calibrating the retinal blood vessels in man. It is common knowledge among observers who have concerned themselves with the technique of fundus photography, that no exhaustive photographic study can be made on the retinal vessels until definite progress has been made in increasing the magnification of the optical system, the efficiency of which is measured by the resolving power.

The technical difficulties associated with increasing the magnification are manifold. To the casual observer it might

* From the Department of Ophthalmology, Northwestern University Medical School. Presented before the Association for Research in Ophthalmology, New York, June 11, 1940. This work was made possible by a grant from the John and Mary R. Markle Foundation.

seem a simple matter to do this by any one of the following methods: 1. The use of a Koeppe[4] contact glass in conjunction with either the Lindner[5] monocular corneal microscope or the Leitz Ultrapak vertical illuminator as described by Lambert. 2. By reducing the focal length of the Nordenson photographic objective in proportion to the increase in magnification desired. 3. By incorporating a microscope ocular in the image plane of the Nordenson camera[6] and connecting this to the reflex housing by means of a draw tube.

During the course of this work the first method was tried. The monocular corneal microscope, which was designed by Lindner for alternate use with the slitlamp, permits an acute angle of observation relative to the axis of illumination. When used with the Koeppe contact glass the fundus can be examined microscopically under focal illumination and, in combination with the Leica and its reflex housing, permits low-power photomicrography. This technique, however, was found impractical because the patients invariably moved after the administration of drugs, and bubbles collected under the contact glass. The same difficulties were experienced when using the Leitz Ultrapak vertical illuminator with the patient in a recumbent position.

The second method was then attempted. This necessitated the construction of a new camera, as the Nordenson instrument does not lend itself to the alterations which require placing the photographic objective nearer the instrument objective. During the first few months of this investigation much time was devoted to the construction of such a camera. The combination of poor illumination and increased magnification in the instrument made it impractical and it was necessary temporarily to abandon it.

The third method, the incorporation of a microscope ocular in the Nordenson camera, was then tried. This was accomplished by removing the reflex-mirror housing on the back of the Nordenson camera and substituting an adapter which held a 5× periplane ocular in the image plane of the photographic objective. This adapter was then connected through a sliding draw tube to the reflex housing and the distance between the ocular and the film plate adjusted so that a magnification of 12× to 15× was secured. Photographs made with this setup immediately demonstrated the inherent optical defects that arise in images from a homocentric system of lenses. In the first place, the increased magnification accentuated the movements of the patient. To overcome this, the exposure time was decreased, and this at once made it necessary to substitute fast panchromatic for the orthochromatic film. In spite of the addition of red-free filters the increased speed was secured only at the expense of sharp contrast. It was obvious then that the increased aberrations had reduced the resolving power of the system as compared with photographs made under lower magnification. In order to produce photomicrographs with greater resolution, it was considered necessary to return to low-power photomicrography and depend upon the application of fine-grain developing and critical enlarging to secure the magnification necessary for the study of minute caliber changes.

This was accomplished by first adapting the Leica camera to the Nordenson instrument, facilitating the speed at which the pictures could be taken, and making Agfa fine-grain plenachrome film available for the work. Figure 1 shows the combination of Leica camera and reflex housing attached to the instrument. The E. Leitz Company coöperated by making a special adapter to permit the use of their right-angle 5× magnifier in place of the regular vertical eyepiece. A thin cov-

er glass was cemented to the ground glass in the reflex housing to aid in critical focusing.

The second step was the application of fine-grain developing. It must be remembered that a photographic emulsion consists of a light-sensitive halide whose chemical composition is altered when the silver salt is exposed to light. During development, metallic silver is formed in direct proportion to the amount of light that strikes the emulsion and there is a tendency for the silver halide to collect in clumps which produce the so-called "grain" in the film. The problem then confronting the photographic chemist is the formation of a developer which will reduce the silver halide while avoiding the clumping of individual particles. Such a developer has been compounded by Champlin[7] and is known as Champlin #15. After trying a number of the so-called fine-grain developers this was selected as the one which came nearest to fulfilling the requirements for this study.

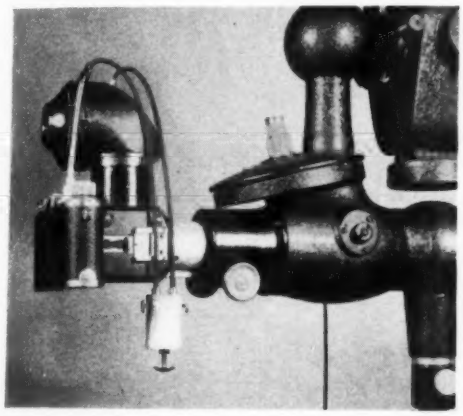

Fig. 1 (Puntenney). The Leica camera adapted for use with the Nordenson instrument.

Experimental studies

In accord with current physiological teachings, the factors which favor vaso-dilatation can be divided into two groups. The first of these, a reduction in volume pressure of the ocular contents, can be achieved by the physical withdrawal of aqueous from the anterior chamber. The second group of factors is more complex and it embraces alterations achieved directly by the administration of parasympathomimetic drugs, or indirectly through passive dilatation following the increase in arterial tension either by sympathomimetic or reflex vaso-pressor stimulation.

Fig. 2 (Puntenney). The Kukan ophthalmodynamometer.

In clinical studies of the retinal vessels it is not only impossible to perform paracentesis at will, but especially difficult to secure clear photographs after a paracentesis has been performed. The nearest approach to such a problem is the substitution of a procedure which will partially reduce the volume pressure of the aqueous and at the same time be safe and easily adapted to photography. Such a method is found in the technique described by Kukan for ophthalmodynamometry. His ingenious device, which apparently has been used very little as a mechanical expedient for reducing intraocular pressure, consists of a negative pressure system involving a manometer, sucking disc, and

suction pump (fig. 2). According to the relationship expressed by Kukan,[8] positive pressure can be applied to the eyeball when the sucking cup is held in apposition to the globe and negative pressure applied (fig. 3). He has shown mathematically that the pressure which

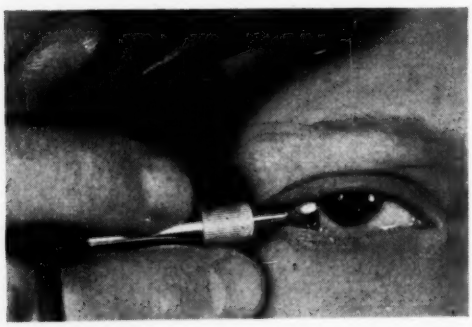

Fig. 3 (Puntenney). Positive pressure being applied to the globe by the Kukan sucking cup.

sucks the cup simultaneously delivers pressure to the rim of the cup; when the surface area of this sucking portion exceeds that of the rim, compression occurs and the intraocular tension rises. After compression has been maintained for a short period of time the aqueous is forced out of the anterior chamber and the blood flow is markedly diminished, with a subsequent drop in the intraocular pressure.

In this work the study of the second group was divided into the following procedures:

1. Administration of drugs and physical stimuli which lessen the tone of the vascular musculature: (a) amyl nitrite; (b) mecholyl; (c) barbiturates; (d) heat.

2. Administration of physical stimuli (cold pressor) which might produce passive dilatation following an increase in arterial tension.

Results

Reduced intraocular pressure. To ascertain the reduction in intraocular pressure following the application of the Kukan ophthalmodynamometer, measurements were made on 10 normal patients seen during the course of homatropine-paredrine refractions. The 11-mm. sucking disc was placed on the temporal conjunctiva within 3 mm. of the limbus, and a negative pressure of 150 mm. of mercury was maintained for two minutes. The results, which are illustrated graphically (fig. 4), show an average reduction in tension of 46 percent, with a gradual return to normal within 45 minutes.

A second group of 10 patients was photographed before, during, and after the application of the instrument. Figure 5 demonstrates the findings, which were relatively constant throughout the series. Under maximum pressure the average caliber of the arteries and veins was reduced approximately 20 percent and 30 percent, respectively. When the sucking

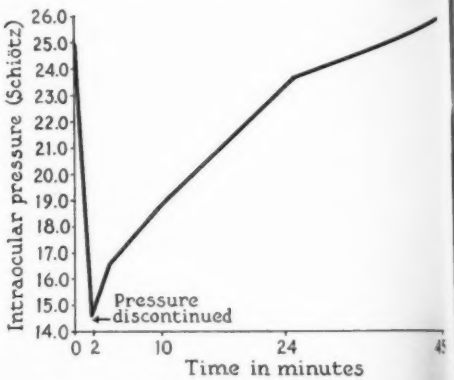

Fig. 4 (Puntenney). Curve showing the reduction in intraocular pressure following the application of the Kukan ophthalmodynamometer.

cup was removed, with a subsequent drop in intraocular pressure, the veins and arteries instantly became flushed, and in eight cases the caliber of the veins increased approximately 10 percent, with a slight prolonged increase in the caliber of the arteries in three cases (see fig. 5).

Amyl nitrite. In this group 22 patients

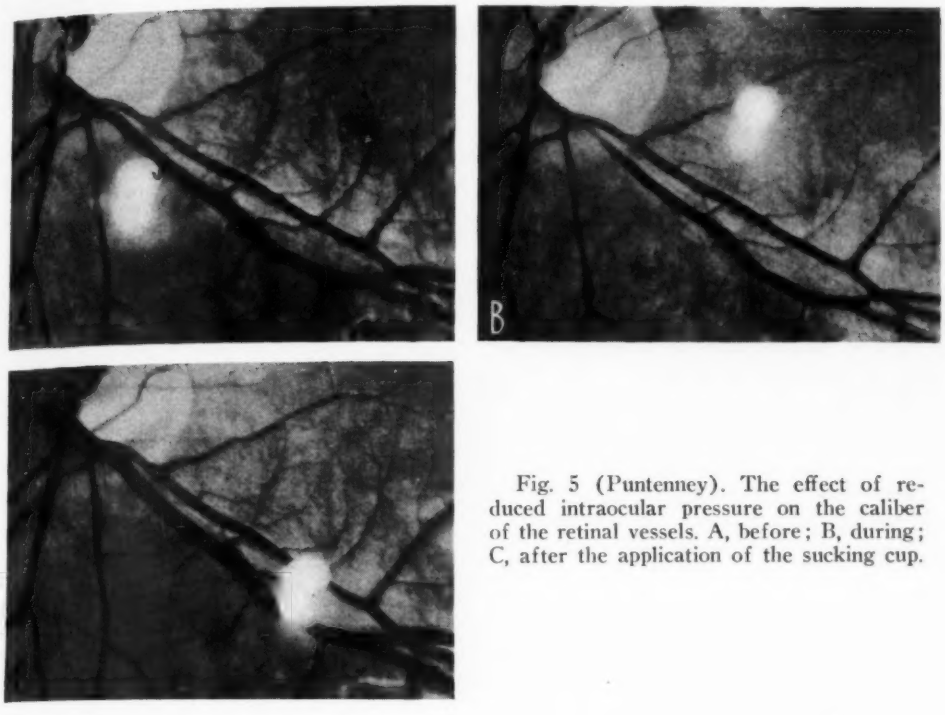

Fig. 5 (Puntenney). The effect of reduced intraocular pressure on the caliber of the retinal vessels. A, before; B, during; C, after the application of the sucking cup.

were photographed before and after the inhalation of 5 min. of amyl nitrite. The first 16 were normal persons seen during the course of homatropine-paredrine refractions. The remaining six were patients selected from the cardiovascular clinic, showing diffuse angiospasm with systolic and diastolic pressures well above normal. In two normal persons the veins dilated slightly and there was a moderate dilatation of the arteries in one (fig. 6). The drop in systolic arterial tension, although varying considerably, did not exceed 40 mm. of mercury in the normal group. No caliber changes occurred in the patients showing diffuse angiospasm.

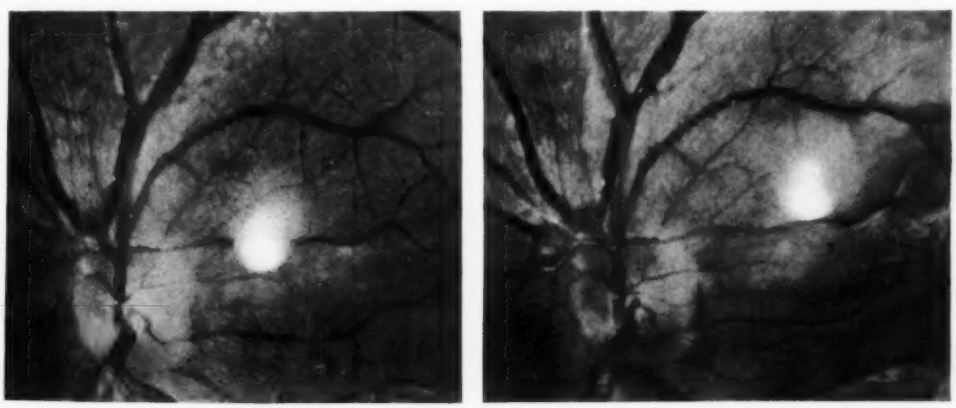

Fig. 6 (Puntenney). The effect of amyl nitrite on the caliber of the retinal vessels. A, before inhalation; B, after inhalation.

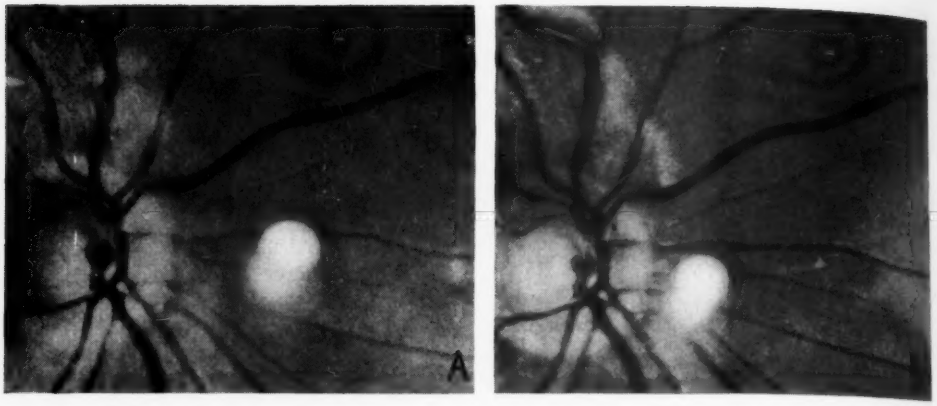

Fig. 7 (Puntenney). The effect of a subcutaneous injection of 6 mg. of mecholyl on the caliber of the retinal vessels. A, before injection; B, after injection.

Mecholyl (acetylbetamethylcholine chloride). Eight patients were photographed in this group. The first six were selected from the preëclampsia clinic, and all of them appeared to show beginning diffuse angiospasm. Two to 6 mg. of the chloride was injected subcutaneously in nine women, and the systemic reactions were so marked that photographs were secured in only six. The small doses seemed to produce almost as much fall in blood pressure as did larger doses, with an average mean drop of 42 mm. of mercury for the systolic, and 34 mm. of mercury for the diastolic. These blood-pressure readings were made approximately 2½ minutes after the injection of the drug. Examination of the records revealed a slight dilatation of the veins in three cases, with a questionable dilatation of the arteries in one (figure 7).

The remaining two, who were normal patients, received retrobulbar injections of the bromide, the first receiving 10 and the second 22 mg. In the latter case (fig. 8) the drug was injected in split doses over a period of five minutes, during which the fall in systolic pressure did not

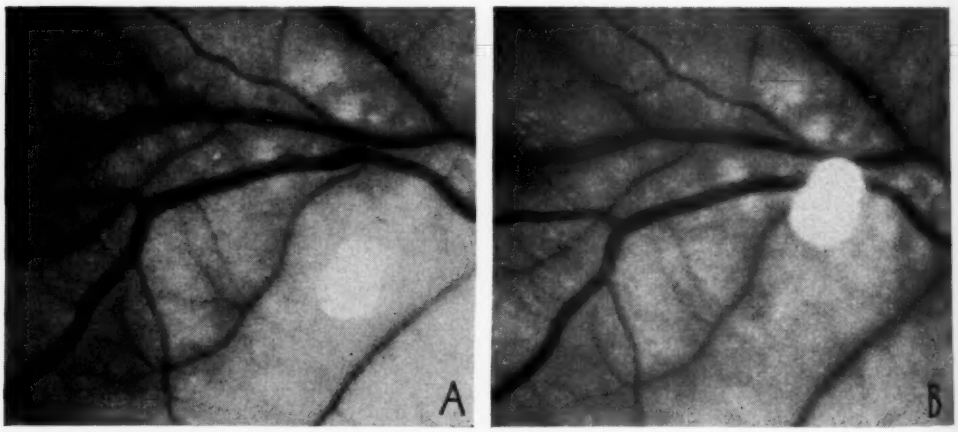

Fig. 8 (Puntenney). The effect of a retrobulbar injection of mecholyl on the caliber of the retinal blood vessels. A, before; B, after the injection.

exceed 22 mm. of mercury. There was no alteration in the caliber of the arteries and veins in either case.

Barbiturates. Only one case can be reported in this group. Nembutal gr. 4½ by mouth produced no change in the caliber of the arteries and veins after one hour.

Heat. Although several studies were made in this group, the technical difficulties associated with photographing the patient in a recumbent position, together with poor ocular fixation induced by fever, has resulted in clear photographs in only one case. This patient, a white woman aged 25 years, was being treated by Dr. S. L. Osborne for nonspecific arthritis in the physiotherapy clinic of Northwestern University. Photographs were made before, during, and after the cabinet treatment, in which the patient's temperature was maintained at 104°F. for four hours. There was no evidence of arterial caliber changes at any time throughout the treatment, but the veins dilated slightly when the temperature peak was first attained.

Cold pressor tests. These studies were performed according to the standard method described by Hines and Brown[9] for measuring the generalized vasomotor tonus. Eight patients were selected from the cardiovascular clinic, each showing well-advanced symptoms and findings of diffuse arteriolar constriction. The patients were seated in a warm draft-free room for one hour, during which time their pupils were dilated. A blood pressure cuff was then placed on the right arm and the opposite hand was immersed in ice water for 1½ minutes. During this time blood-pressure readings were made at one-half-minute intervals and continued for five minutes. Photographs were made before, during, and after the immersion of the hand in ice water. The average mean rise in blood pressure with the cold pressor tests was 29 mm. of mercury for the systolic and 20 mm. of mercury for the diastolic. There was no demonstrable variation in caliber of the larger vessels, and no detailed difference could be observed in the minute vessels surrounding the macula.

Discussion

The existence of vasodilator and vasoconstrictor nerves, which supply the retinal blood vessels, has never been conclusively demonstrated. Duke-Elder has shown this in his summary of the experimental work. Likewise, there seems to be little proof that there are Rouget cells, or that they account for spasms which occur in the retinal arterioles. For our purpose it is profitless to theorize upon such mechanisms. We do know, however, that the equilibrium which is maintained in the retinal circulation depends on the delicate adjustment between intraocular pressure, arterial tension, and the capillary bed. Further, we have seen that although certain forceful disruptions of this state of equilibrium are capable of producing vasodilatation, nevertheless, the prevailing tendency is by nature compensatory and results in little if any change in the caliber of the arteries.

An interesting confirmation of the latter is found in the studies made with amyl nitrite. In only one case was there a slight increase in the caliber of the arteries; I believe this is the first photographic evidence that has been presented to prove that the arteries do occasionally dilate under the influence of nitrites. In all but this one case the work agrees essentially with the findings of Haessler and Squier;[10] also with that of King.[11] An increase in caliber of the veins, which occurred in two cases, seems to be an indication of an accentuated flow through the capillary bed. Additional proof of this latter generalization is found in the consistent increase in the caliber of the veins in the studies conducted with the Kukan

apparatus. At the same time it was observed that the arteries momentarily showed an increase in caliber coexistent with the removal of the sucking cup. This flushing of the vessels had the characteristics of a rebound phenomenon, so fleeting that it was difficult to photograph.

The studies with mecholyl in cases of early diffuse retinal arteriolar constriction were made in a relatively small series. The marked generalized reactions observed in several of the cases were so alarming that further studies were considered inadvisable. These reactions were characterized chiefly by a flushing of the face, increased flow of saliva, dyspnea, precordial pain, and extreme weakness. A hypodermic injection of atropine sulphate gr. 1/150 was given immediately at the onset of these manifestations, with the alleviation of severe symptoms within 0.5 to 2 minutes. The mean fall in blood pressure of 42 mm. of mercury for the systolic and 34 mm. of mercury for the diastolic, does not give a true record of the initial fall in pressure, as these readings were taken after several exposures had been made. This does not point very favorably to the therapeutic value of mecholyl in such cases, but it does denote the presence of a vasodilator mechanism capable of maintaining the *status quo* of the arterioles throughout a marked reduction in generalized arterial tension.

A more favorable relationship for the study of circulatory changes was found in the two normal persons receiving mecholyl bromide retrobulbarly. This was demonstrated by the slight generalized reaction and the moderate fall in blood pressure. The negative results suggest further study.

The cold pressor tests were undertaken with the hope of accentuating diffuse arteriolar constriction. Hines and Brown have shown that "in essential hypertension 98 percent of the patients have abnormal ranges and abnormal maximal responses to the test." It follows that a stimulation of a labial vasomotor system might produce either a passive dilatation of the retinal arteries, secondary to an increase in arterial tension, or a constriction of the capillary bed with subsequent changes in the caliber of both the arteries and veins. The negative findings prove that the determination of such delicate fluctuations are well beyond the scope of our present photographic methods of examination.

To substantiate the contention that the increase in the caliber of the veins is associated with an increased flow through the capillary bed, it is obvious that a practical method must be devised for determining the variations in capillary pressure. Duke-Elder has gone to considerable lengths to discredit the numerous procedures which have been advanced to calculate this. He argues, reasonably enough, that "any increase in pressure applied to the globe at once affects the intraocular pressure, through it the venous pressure, and therefore the capillary pressure, the three tending to rise coincidentally but not in parallel." This explains the difficulties encountered in measuring the actual pressure of the capillary bed and renders valueless, at least for this purpose, the figures which may be estimated by ophthalmodynametric determination of arteriolar and venous pressure.

The only method available for determining functional narrowing of the finer retinal arterioles and capillaries is that of entoptoscopy described by Scheerer,[12] Horniker,[13] and others. The patient, seated before a brightly illuminated surface, observes subjectively the movement of small dancing spots which are thought to be corpuscles in the perifoveal capillaries. In retinal ischemia, following constriction of the capillary bed, Horniker believes there is a slowing down of the

particles and an enlargement of the avascular macula. This test has the disadvantage of all subjective examinations, but it affords a method for pharmacologic study of the capillary bed, especially in essential hypertension and in central angiospastic retinopathy, recently described by Gifford and Marquardt.[14]

Practical application. The photographs presented help to establish several important points. They show that some progress can be made toward the solution of the problem with the equipment and methods now available. Inaccuracies introduced by this method are, I believe, less objectionable than those found in direct readings made by the split-prism ocular of Lobeck.[15] Likewise, the objective evidence establishes the presence of a weak expansile mechanism in the retinal arteries and suggests that the increase in caliber of the veins is a passive reaction secondary to the dilation of the capillary bed. I believe the Kukan apparatus should be used at the onset in treating all cases of occlusion of the central artery and its branches. It offers an ideal method of administering massage, and permits examination of the retina throughout the course of this treatment. Ophthalmologists who are interested enough to use it in conjunction with the binocular ophthalmoscope will be amazed with the ease at which the study can be conducted, and it will add greatly to the therapeutic evaluation of massage.

Summary

1. Methods for photographing the retinal blood vessels in man have been discussed.

2. The Kukan ophthalmodynamometer has been used experimentally for lowering the intraocular tension.

3. New photographic evidence has been presented with the following findings: (a) The inhalation of amyl nitrite in 22 patients produced dilatation of the veins in two, and a slight dilatation of the arteries in one. (b) Intraocular pressure reduced with the Kukan apparatus in 10 patients produced an increase in the caliber of the veins in eight, with a slight increase in the caliber of the arteries in three. (c) Injections of mecholyl in eight cases produced a dilatation of the veins in three cases, with a questionable dilatation of the arteries in one. (d) No increase in the caliber of the vessels was observed after nembutal and cold pressor tests. (e) One patient photographed during hyperpyrexia treatment showed a questionable dilatation of the veins.

4. The value of entoptoscopy in determining functional narrowing of the capillaries has been discussed.

5. The Kukan ophthalmodynamometer has been recommended for massage during treatment following occlusion of the central artery.

I wish to thank Dr. Sanford R. Gifford for his aid and encouragement.

303 East Chicago Avenue.

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Discussion

Dr. Frederick H. Verhoeff: I should like to ask the essayist a question. Do you think that the central artery of the retina has any nerve supply to the media?

Another question I should like to ask is, in view of your studies, do you think that there is such a thing as an arteriole spasm, and if so, what do you think causes that?

Dr. Puntenney: I do not think that any one has ever proved the existence of vasodilator fibers supplying the media of the central artery of the retina. In so far as vaso spasm is concerned, I cannot venture further explanation, for unfortunately no one knows the answer to it.

Dr. Verhoeff: Do you think it really occurs?

Dr. Puntenney: Yes, I think it occurs, because I have seen it. I haven't followed along with pictures, which I should like to do some time, but I am convinced it does occur.

Dr. Verhoeff: You mean you have observed it come and go?

Dr. Puntenney: I have seen the caliber of the vessels vary; I have seen the spasm pass down the vessel, appear at one point, and then later, at another point, especially in the essential hypertension and preëclampsia cases, in which there was marked spasm of the vessels. I cannot give a good explanation for it.

A STUDY OF PRACTICAL CYCLOPLEGIA

WITH SPECIAL REFERENCE TO THE USE OF PAREDRINE. A REVIEW OF 341 CASES

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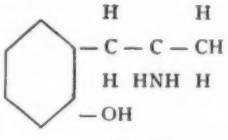
Youngstown, Ohio

In the last few years, the use of Benzedrine* or paredrine as an adjunct in the production of cycloplegia by atropine or homatropine has been recommended by a number of investigators, who claim that these adrenergic compounds exert a synergistic action that heightens the cycloplegic effect of atropine and its derivatives. In several studies, the conclusion has been reached that when these drugs are used as adjuvants, smaller quantities of the cycloplegic are required to depress accommodation, and that the period of accommodative disability after refraction is shortened.

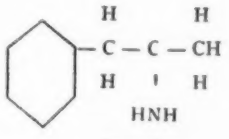
The principal factors to be considered in the production of cycloplegia are: (1) the degree of depression of accommodative power without harmful effect; (2) the speed with which the maximum depression is produced; (3) the length of the period during which cycloplegia is maintained; and (4) the time required for complete recovery of accommodation. Any drug or technical modification that gives promise of fulfilling these conditions more satisfactorily is worthy of thorough investigation.

The recommendations made for Benzedrine and paredrine have served to stimulate interest in the subject of cycloplegia and to focus attention on the technique, resulting in a reëxamination of the methods of the procedure and their rationale.

Benzedrine (a-methylphenethylamine) and paredrine (p-hydroxy-a-methylphenethylamine) are closely related compounds whose only difference in structure is that paredrine has an hydroxyl radical in the para position.



Paredrine



Benzedrine

In the earlier investigations on cycloplegic effect, Benzedrine sulphate was used, and paredrine has been employed in the more recent studies. Myerson and Thau[1] were the first to suggest that Benzedrine sulphate might be useful as an adjunct to atropine in the preparation of eyes for refraction. In 1937, Beach and McAdams[2] first published their studies on the subject, and advocated the use of a solution of Benzedrine sulphate (1 percent) in conjunction with 1-percent atropine or 5-percent homatropine. They concluded that, with this technique, the cycloplegic effect reached its height in 50 to 70 minutes, and that the effect was considerably shortened. In 25 cases, a comparison showed a greater depth of cycloplegia (0.35 diopter sphere) with the conventional homatropine method than with the Benzedrine-homatropine method. In another group of 27 cases, in which atropine was used, a comparison of the effects of the usual atropine method and the atropine solution used in combination with 1-percent Benzedrine sulphate showed that the cycloplegic depth was .23 diopter sphere greater in the former.

Powell and Hyde[3] confirmed the findings of Beach and McAdams. They compared the cycloplegic effect of the instillation of two drops of 2-percent homatropine hydrobromide into the conjunctival sac, three minutes apart, in conjunction with two drops of 1-percent Benzedrine sulphate, with that of the conventional homatropine method of 2-percent homat-

* At the request of the producers of Benzedrine (Smith, Kline, and French), the word is capitalized.

ropine hydrobromide in four instillations. They reported that only a small number of patients who received homatropine alone displayed a complete return of accommodation at the end of 18 hours, while the patients who received the cycloplegic in combination with Benzedrine showed a complete or nearly complete return of accommodation at the end of eight hours. These authors stated also that the pupils were slightly larger, and the corneas definitely clearer in the cycloplegic state in those patients who received instillations of homatropine and Benzedrine than in those who received homatropine only.

It should be noted that Powell and Hyde used twice the number of instillations of 2-percent homatropine in the cases in which the Benzedrine was omitted, and hence it would appear that the delayed accommodative recovery might be accounted for in this group by the greater quantity of cycloplegic used.

In one portion of his study on homatropine-Benzedrine cycloplegia, Sudranski[4] reported the results of an investigation of 25 patients on whom he made comparative measurements of the residual accommodation following the use of 1 drop of 5-percent homatropine and 1 drop of 1-percent Benzedrine sulphate in one eye, and 5-percent homatropine hydrobromide in the other eye. The quantity of homatropine instilled varied with the age of the patient, with four instillations in patients aged less than 40 years, three instillations in those aged from 40 to 50, and two instillations in those aged from 50 to 60 years. The residual accommodation was measured by the artificial-myopia test, and there was no instance in which this exceeded one diopter. The average difference in the two eyes was merely 0.9 cm., which represents a small fraction of a diopter, and proved that the homatropine-Benzedrine method was only slightly less effective than the usual homatropine method. Sudranski concluded that there was greater mydriasis when the cycloplegic drug was combined with Benzedrine, and that the cycloplegia was of shorter duration. Here again, the quantities of homatropine used in the eyes compared were not the same when Benzedrine was employed as when the cycloplegic was used alone, and hence this factor, rather than the Benzedrine, may have influenced the results.

In a pharmacologic study of paredrine, Abbott and Henry[5] reported the effects of this drug on the human eye. They reported that it is nonirritating to mucous membranes, produces no increase in the intraocular tension, and that the possibility of stimulation of the central nervous system was slight. They observed no cycloplegic effect but reported that when paredrine was dropped into the conjunctival sac, it produced a mydriasis that lasted about six hours.

Tassman[6] made a study of the use of paredrine hydrobromide in combination with 1-percent atropine sulphate in patients less than 16 years of age, and with 4-percent homatropine hydrobromide in patients more than 16 years of age. He made comparative observations in the same patient, at different times, of the effects of the cycloplegic drug alone and in combination with paredrine. The results of these two methods were essentially the same in all cases, in regard to the depth of cycloplegia produced. Tassman believed, however, that the combined method is preferable, in that recovery of accommodation was more rapid than when atropine or homatropine was used alone.

In discussing Powell's[7] presentation before the American Academy of Ophthalmology and Otolaryngology, Rutherford concluded that Benzedrine and paredrine do not augment the degree of cycloplegia

obtained by the use of homatropine, but that they do increase mydriasis and shorten the period of accommodative disability.

Our own findings do not coincide with these previously reported studies. We were unable to demonstrate that paredrine enhances the cycloplegic effect when equal quantities of homatropine or atropine are used in the eyes compared, or that the period of accommodative disability is appreciably shortened by its use. We observed little or no increase of mydriasis at the end of one hour, when paredrine was used in combination with the cycloplegic drug. The only group of patients in whom paredrine increased mydriasis was one of elderly patients who received euphthalmine preparatory to fundus examination. In most cases, an added dilatation was produced by paredrine when euphthalmine had not been entirely satisfactory.

Methods and results

In our earliest observations, we accepted paredrine as an adjuvant to homatropine, and hence the tabulated results show the effects of this combination of drugs. In later studies, the effect of a certain quantity of homatropine or atropine is compared with the effect of the same quantity of cycloplegic in the other eye, with paredrine added.

The range of residual accommodation has been calculated by ascertaining the difference between the near point and the far point, and transposing this into diopters. A Prince rule with Jaeger test type no. 1 was used to ascertain the far and near points, after adding a plus-three sphere to the distance cycloplegic finding. We have found this method of calculating the residual accommodation more satisfactory than that when the near point alone was measured. The latter method yields a consistently lower value than when the range is determined by measuring the difference between the far and near points. Prangen,[8] who uses the same method of calculating the residual accommodation, has shown that the value should be three diopters or less, if the cycloplegia is satisfactory for determining the refractive error. In another study,[9] he showed that reduction of the range of accommodation below 2.2 diopters, by increasing the cycloplegic effect, does not uncover additional latent error. In aphakic eyes, we have found the average range of accommodation to be .87 diopter.

The preparation of paredrine used in our studies was a 1-percent solution of paredrine hydrobromide with boric acid ophthalmic.*

In the first four charts the results of the use of paredrine and homatropine are shown in four age groups: 8 to 15 years (chart 1); 16 to 25 years (chart 2); 26 to 35 years (chart 3); and 36 to 45 years (chart 4). In each instance, one drop of the homatropine was instilled in the conjunctival sac of each eye, followed by instillation of the 1-percent paredrine solution in three minutes, and then by additional instillations of homatropine solution. The number of instillations and the concentration of the homatropine solution are clearly indicated in the charts. The retinoscopy and trial-case examinations were made from 60 to 120 minutes after the first instillation of homatropine solution. The range of residual accommodation was measured, with the correction in the trial frame.

The average range of residual accommodation in all these groups was between one and two diopters, although there were four individual instances in the youngest age group, three in the second, and one in the third, in which the residual ac-

* The material used in this study was furnished by Smith, Kline, and French.

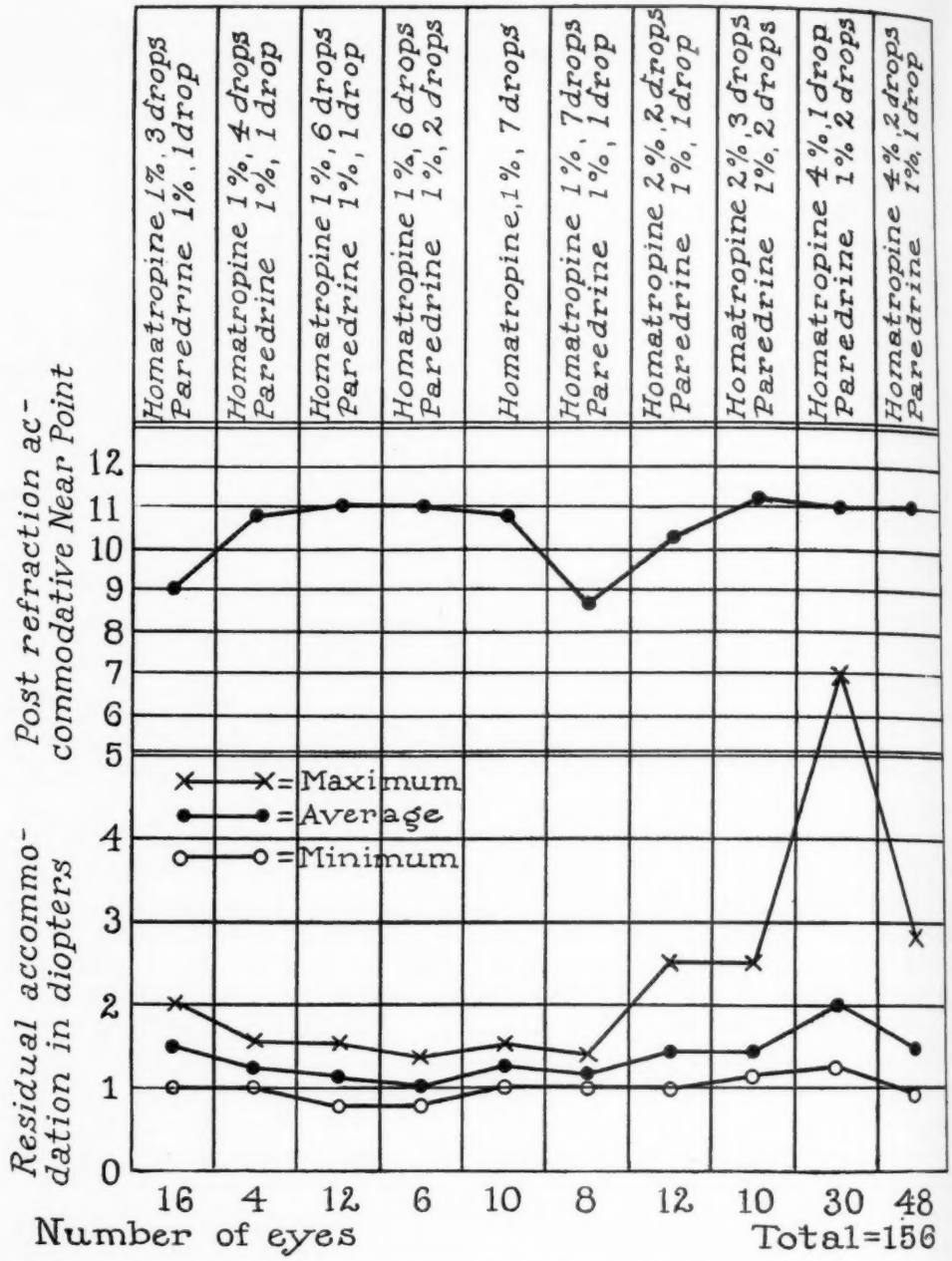


Chart 1 (Wenaas, Evans, and Odom). Cycloplegic effect of homatropine-paredrine at age 8 to 15.

commodation exceeded two diopters. These maximums are shown on the charts.

In the next group of 27 patients, shown in table 1, the following procedure was used: Three drops of 1-percent homatropine solution were instilled at intervals of five minutes in both eyes. One drop of 1-percent paredrine hydrobromide was instilled in the right eye only. Refraction

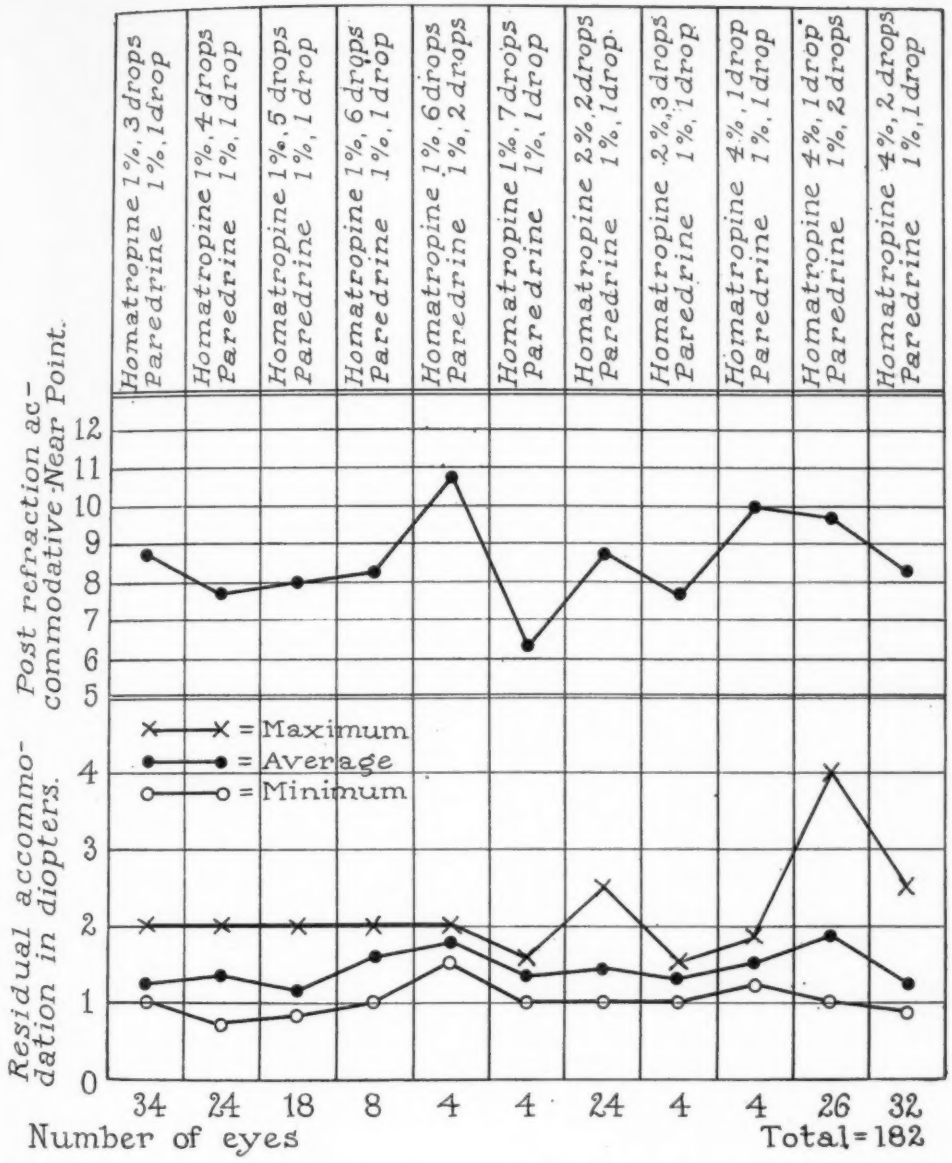

Homatropine 1%, 3 drops Paredrine 1%, 1 drop
Homatropine 1%, 4 drops Paredrine 1%, 1 drop
Homatropine 1%, 5 drops Paredrine 1%, 1 drop
Homatropine 1%, 6 drops Paredrine 1%, 1 drop
Homatropine 1%, 6 drops Paredrine 1%, 2 drops
Homatropine 1%, 7 drops Paredrine 1%, 1 drop
Homatropine 2%, 2 drops Paredrine 1%, 1 drop
Homatropine 2%, 3 drops Paredrine 1%, 1 drop
Homatropine 4%, 1 drop Paredrine 1%, 1 drop
Homatropine 4%, 1 drop Paredrine 1%, 2 drops
Homatropine 4%, 2 drops Paredrine 1%, 1 drop
Post refraction accommodative Near Point.
Residual accommodation in diopters.
0 1 2 3 4 5 6 7 8 9 10 11 12
× = Maximum
● = Average
○ = Minimum
34 24 18 8 4 4 24 4 4 26 32
Number of eyes
Total = 182

Chart 2 (Wenaas, Evans, and Odom). Cycloplegic effect of homatropine-paredrine at age 16 to 25.

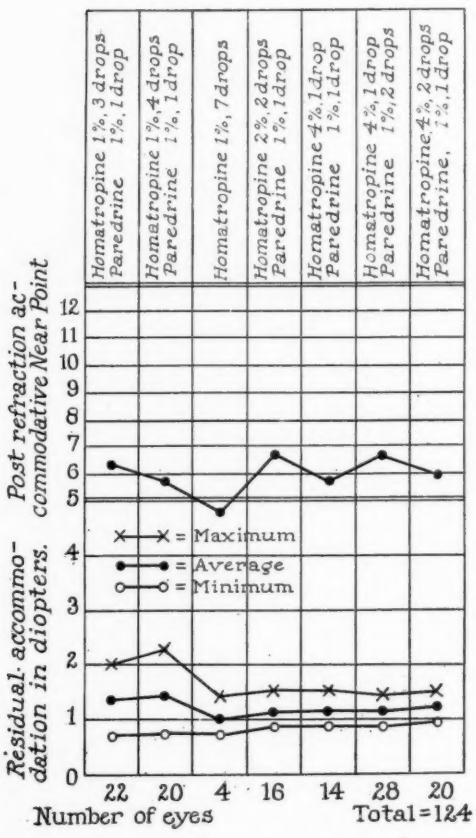
was carried out one hour after instillation of the cycloplegic. The range of residual accommodation was measured. A postrefraction examination was made no sooner than three days later. The accommodative near point was measured.

In another group of 27 patients (table 2), the procedure was the same, except that 2-percent homatropine was instilled twice in each eye, and 1-percent paredrine in the right eye only.

In 22 patients (table 3), a single instillation of 5-percent homatropine solution was made in each eye, and one instillation of paredrine in the right eye.

In this group of 76 patients in which

there were three different dosages of the cycloplegic, compared with the same quantity of homatropine plus the instillation of one drop of 1-percent paredrine solution in one eye, the average range of time of recovery of accommodation, or to measure the size of the pupil, but the patients were requested to observe which eye they could use first, and to report any difference noted in the size of the pupils.


Homatropine 1%, 3 drops Paredrine 1%, 1 drop
Homatropine 1%, 4 drops Paredrine 1%, 1 drop
Homatropine 1%, 7 drops
Homatropine 2%, 2 drops Paredrine 1%, 1 drop
Homatropine 4%, 1 drop Paredrine 1%, 1 drop
Homatropine 4%, 1 drop Paredrine 1%, 2 drops
Homatropine 4%, 2 drops Paredrine 1%, 1 drop
Post refraction accommodative Near Point
Residual accommodation in diopters.
= Maximum
= Average
= Minimum
22 20 4 16 14 28 20
Number of eyes
Total=124

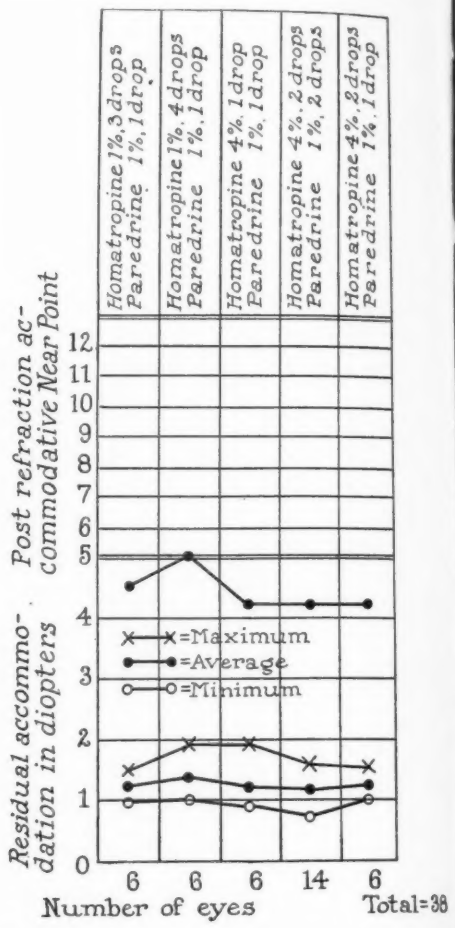

Homatropine 1%, 3 drops Paredrine 1%, 1 drop
Homatropine 1%, 4 drops Paredrine 1%, 1 drop
Homatropine 4%, 1 drop Paredrine 1%, 1 drop
Homatropine 4%, 2 drops Paredrine 1%, 2 drops
Homatropine 4%, 2 drops Paredrine 1%, 1 drop
Post refraction accommodative Near Point
Residual accommodation in diopters
=Maximum
=Average
=Minimum
6 6 6 14 6
Number of eyes
Total=38

Chart 3 (Wenaas, Evans, and Odom), left. Cycloplegic effect of homatropine-paredrine at age 26 to 35.

Chart 4 (Wenaas, Evans, and Odom), right. Cycloplegic effect of homatropine-paredrine at age 36 to 45.

residual accommodation in the right eye, in which paredrine was used, was 1.527 diopters, while in the left eye, it was 1.512 diopters. The difference (0.015 diopter) is negligible.

It was not practical in these 76 cases to make repeated observations as to the They were given no suggestions as to which eye would probably recover sooner, and there was no consistency or uniformity in their reports. In many of these cases, a miotic was instilled following refraction, to hasten the recovery of accommodation. These patients were se-

TABLE 1

CYCLOPLEGIC EFFECT OF HOMATROPINE-PAREDRINE

(3 drops of 1-percent homatropine in both eyes, and 1 drop of 1-percent paredrine in the right eye only)

Age	Refractive Error	Number of Cases	Average Residual Accommodation (diopters)		Greatest Residual Accommodation (diopters)		Lowest Residual Accommodation (diopters)		Average Post-Refraction Accommodative Near Point	
			O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.
8 to 15	Hyperopia	2	1.50	1.9	1.50	2.50	1.50	1.50	11.5	11.5
	Myopia	4	1.9	1.9	2.75	3.00	1.37	1.37	8.5	8.0
16 to 25	Hyperopia	8	1.62	1.67	2.37	2.37	0.75	1.12	9.5	9.4
	Myopia	8	1.48	1.44	1.87	1.87	1.12	1.12	7.9	8.2
26 to 35	Hyperopia	3	1.54	1.54	1.75	2.00	1.37	1.00	6.2	6.0
	Myopia	2	1.25	1.50	1.50	2.00	1.00	1.00	6.5	6.5
	Total	27	1.57	1.66	Difference—0.088 diopter					

TABLE 2

CYCLOPLEGIC EFFECT OF HOMATROPINE-PAREDRINE

(2 drops of 2-percent homatropine in both eyes, with 1 drop of 1-percent paredrine in the right eye only)

Age	Refraction	Number of Cases	Average Residual Accommodation (diopters)		Greatest Residual Accommodation (diopters)		Lowest Residual Accommodation (diopters)		Average Post-Refraction Accommodative Near Point	
			O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.
8 to 15	Hyperopia	None								
	Myopia	4	1.75	1.94	2.50	2.50	1.25	1.50	10.9	10.9
16 to 25	Hyperopia	5	1.40	1.30	1.50	1.50	1.25	1.00	8.5	8.6
	Myopia	4	1.44	1.07	1.50	1.50	1.25	1.12	10.1	10.3
26 to 35	Hyperopia	10	1.41	1.34	1.75	1.75	1.12	1.25	6.3	6.4
	Myopia	None								
36 to 45	Hyperopia	4	1.18	1.06	1.62	1.37	0.75	0.75	4.7	4.7
	Myopia	None								
	Total	27	1.43	1.34	Difference—0.088 diopter					

TABLE 3

CYCLOPLEGIC EFFECT OF HOMATROPINE-PAREDRINE

(1 drop of 5-percent homatropine in both eyes, with 1 drop of 1-percent paredrine in the right eye only)

Age	Refraction	Number of Cases	Average Residual Accommodation (diopters)		Greatest Residual Accommodation (diopters)		Lowest Residual Accommodation (diopters)		Average Post-Refraction Accommodative Near Point	
			O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.
8 to 15	Hyperopia	1	1.87	1.87	1.87	1.87	1.87	1.87	13.0	
	Myopia	None								
16 to 25	Hyperopia	11	1.65	1.62	2.00	2.00	1.37	1.25	9.0	8.9
	Myopia	None								
26 to 35	Hyperopia	8	1.57	1.60	2.25	2.37	1.25	1.25	7.8	7.8
	Myopia	1	1.25	1.25	1.25	1.25	1.25	1.25	8.5	8.5
36 to 45	Hyperopia	1	1.25	1.25	1.25	1.25	1.25	1.25	7.0	7.0
	Myopia	None								
	Total	22	1.59	1.58	Difference—0.009 diopter					

TABLE 4

ACCOMMODATIVE RECOVERY AFTER HOMATROPINE-PAREDRINE CYCLOPLEGIA

(1 drop of 5-percent homatropine in both eyes, with 1 drop of 1-percent paredrine in the right eye only)

Age	Refractive Error	Time (hours)	Accommodative Near Point (diopters)		Size of Pupils (millimeters)	
			O.D.	O.S.	O.D.	O.S.
18	Hyperopia	1	1.62	1.62	8	8
		18	4.0	4.0	6	4
		40	14.0	14.0		
19	Hyperopia and astigmatism	1	1.50	1.50	8	8
		17	2.50	2.75	6.5	6
		22	3.00	3.50	5	5
		46	6.0	6.0	3	3
20	Hyperopia and astigmatism	1	1.50	1.50	8	8
		20	5.50	5.50		
		44	7.50	7.50		
13	Hyperopia and astigmatism	1	1.87	1.87	8	7
		4.5	3.37	3.37	8	7
		23	5.50	5.50	5	6
		48	11.0	11.0	3	3
24	Hyperopia and astigmatism	1.5	2.0	1.75	8	8
		18	6.5	7.0	5	3
		64	11.0	11.0	3	3
23	Myopia and astigmatism	1	1.75	1.75		
		18	3.75	4.25		

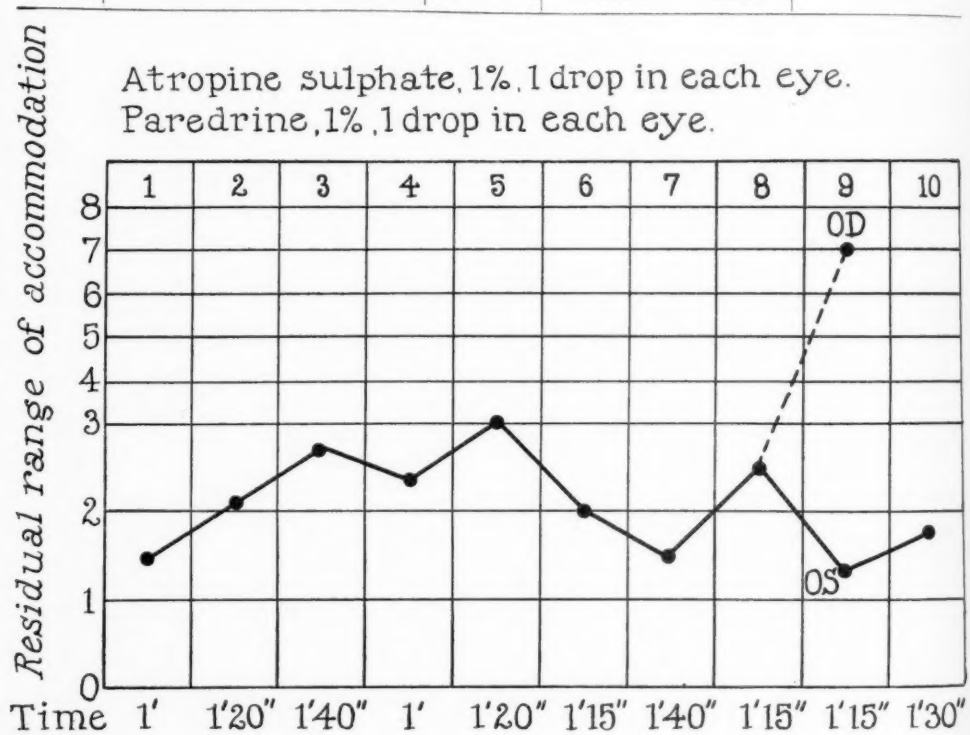

Atropine sulphate, 1%, 1 drop in each eye.
Paredrine, 1%, 1 drop in each eye.
Residual range of accommodation
1 2 3 4 5 6 7 8 9 10
0 1 2 3 4 5 6 7 8
OD
OS
Time 1' 1'20" 1'40" 1' 1'20" 1'15" 1'40" 1'15" 1'15" 1'30"

Chart 5 (Wenaas, Evans, and Odom). Residual range of accommodation after homatropine-paredrine cycloplegia in children between 7 and 12 years of age.

lected because of their ability to coöperate, and because it was believed their observations would be reliable.

In a group of six patients whose ages ranged from 13 to 24 years, no miotic was administered following refraction with 5-percent homatropine solution, and series of 10 children between 7 and 12 years of age, one drop of 1-percent atropine solution, and one drop of 1-percent paredrine solution were instilled into both eyes, and the examination was made from 1 to 1¾ hours later. The depression of accommodation was the same in both eyes

TABLE 5

ACCOMMODATIVE RECOVERY AFTER ATROPINE-PAREDRINE CYCLOPLEGIA

(1 drop of 1-percent atropine in both eyes, with 1 drop of 1-percent paredrine in the right eye only)

Age	Refractive Error	Time (hours)	Accommodative Near Point (diopters)		Size of Pupils (millimeters)	
			O.D.	O.S.	O.D.	O.S.
13	Hyperopia	0	9.5	9.5	4	4
		1.25	1.62	1.62	8.5	8.5
		18	2.25	2.25	8.5	8.5
		70	4.25	4.25	7	7
15	Myopia	0	9.0	9.5	4	4
		1.25	1.87	2.12	8	8
		24	2.0	1.75	7	7
		48	2.0	2.0	6	6
		72	2.0	2.0	5	5
		144	2.75	2.75	5	5
		210	4.25	4.25		
10	Hyperopia	0	11.0	11.0	4	4
		1.25	1.50	1.25	8	7
		48	8	6	6	7
		96	10	9	5.5	5.5
		144	11	11	4	4
14	Hyperopia	0	10.5	10.5	3	3
		1.25	1.37	1.50	7.5	7.5
		24	1.50	1.50	7.5	7.5
		72	1.50	1.50	7.5	7.5
		144	3.0	3.00	5	5
		192	4.50	4.50	4	4
12	Myopia	0			3	3
		0.58			8	7
		1.16	1.50	1.25	8	8.5
		100	6.25	4.50	5	5
		148	6.50	6.25	5	5

pupillary measurements showed that dilation of the pupil persisted for a slightly longer period in the eye in which the combination of paredrine and homatropine was used, although the return of accommodation was essentially the same in both eyes (table 4).

Atropine was used as the cycloplegic in two small groups of children. In the first in all but one instance, in which the range of residual accommodation was seven diopters in the right eye, and 2.75 diopters in the left eye one hour after the instillation. An additional drop of 1-percent atropine in the right eye depressed the accommodation to 1.25 diopters. At the end of 2¼ hours the residual accommodation was 1.25 diopters in both eyes. In

the other nine cases in this group, the residual accommodation was reduced to 1.25 to 3.0 diopters (chart 5).

In a group of five children, aged between 10 and 15 years, 1-percent atropine solution was instilled in both eyes, and 1-percent paredrine solution only in the right eye, to determine the comparative range of residual accommodation and the recovery times. As table 5 shows, there was no significant difference in the depression of accommodation or in the recovery time in the two eyes.

The similarity in the degree of cycloplegia effected by various quantities and concentrations of cycloplegic, as measured by the range of residual accommodation in diopters (table 6), corroborates the findings of Prangen[9] and of Thorne and Murphey.[10] These latter investigators studied the effects of various concentrations of cycloplegic drugs, and of various numbers of instillations, and found that one drop of 5-percent homatropine was as satisfactory for refraction as two or three drops, and that the recovery time was more rapid when a smaller quantity was used. The accommodation was depressed to a satisfactory level, below two diopters, for retinoscopy and trial-case examination in 40 to 50 minutes, and recovery to two diopters or more did not occur until four hours had elapsed. The findings were the same with one drop of 5-percent homatropine as with six drops of 2-percent homatropine solution. Their observations on the recovery time in 114 cases indicates that the examination may

TABLE 6

EFFECT OF VARIOUS CONCENTRATIONS OF CYCLOPLEGIC DRUGS IN DIFFERENT AGE GROUPS

(250 CASES)

Age of Patients	8–15 yrs. Group		16–25 yrs. Group		26–35 yrs. Group		36–45 yrs. Group		Total Number of Patients	Average Residual Accomodation (diopters)
Quantity of Cycloplegic	Number of Patients	Average Range of Residual Accommodation (diopters)	Number of Patients	Average Range of Residual Accommodation (diopters)	Number of Patients	Average Range of Residual Accommodation (diopters)	Number of Patients	Average Range of Residual Accommodation (diopters)		
4% homatropine gtts. 2 1% paredrine gtts. 1	24	1.38	16	1.19	10	1.25	3	1.30	53	1.29
4% homatropine gtts. 1 1% paredrine gtts. 1	15	2.03	13	1.69	14	1.12	7	1.31	49	1.57
4% homatropine gtts. 1 1% paredrine gtts. 1	0		2	1.50	7	1.22	3	1.12	12	1.20
2% homatropine gtts. 3 1% paredrine gtts. 1	5	1.28	2	1.25	0		0		7	1.27
2% homatropine gtts. 2 1% paredrine gtts. 1	6	1.52	12	1.38	8	1.04	0		26	1.30
1% homatropine gtts. 7 1% paredrine gtts. 1	4	1.12	2	1.25	0		0		6	1.16
1% homatropine gtts. 7	5	1.40	0		2	1.00	0		7	1.28
1% homatropine gtts. 6 1% paredrine gtts. 2	3	1.00	2	1.62	0		0		5	1.25
1% homatropine gtts. 6 1% paredrine gtts. 1	6	1.12	4	1.62	0		0		10	1.32
1% homatropine gtts. 5 1% paredrine gtts. 1	0		9	1.15	0		0		9	1.15
1% homatropine gtts. 4 1% paredrine gtts. 1	2	1.25	12	1.23	10	1.27	3	1.31	27	1.25
1% homatropine gtts. 3 1% paredrine gtts. 1	8	1.46	17	1.14	11	1.24	3	1.16	39	1.21

be made any time between 50 minutes and three hours after the instillation of the cycloplegic, but that the greatest depression of accommodative function occurs between 1¼ and 1¾ hours after the is administered, the patient may squeeze a portion of it from the conjunctival sac, thus preventing a complete effect. When two drops are used, this likelihood is minimized.

TABLE 7

EFFECT OF VARIOUS CONCENTRATIONS OF CYCLOPLEGIC DRUGS AT DIFFERENT TIME INTERVALS (250 CASES)

Quantity of Cycloplegic	Time (minutes)	No. Eyes	Average Residual Accommodation (diopters)	Greatest Residual Accommodation (diopters)	Lowest Residual Accommodation (diopters)	Average P.R. Accommodative Near Point
4% homatropine gtts. 2	40– 75	54	1.15	2.50	0.75	7.75
1% paredrine gtts. 1	75–120	52	1.12	2.50	0.75	9.15
4% homatropine gtts. 1	40– 75	54	1.64	7.0	0.75	8.2
1% paredrine gtts. 2	75–120	44	1.15	5.0	0.62	7.1
4% homatropine gtts. 1	40– 75	12	1.76	5.0	1.00	7.5
1% paredrine gtts. 1	75–120	12	1.19	1.75	0.75	6.00
2% homatropine gtts. 3	40– 75	2	1.25	1.25	1.25	13.0
1% paredrine gtts. 1	75–120	12	1.37	2.50	0.75	8.5
2% homatropine gtts. 2	40– 75	26	1.05	1.50	0.87	7.7
1% paredrine gtts. 1	75–120	26	1.28	2.50	1.00	9.0
1% homatropine gtts. 7	40 –75	0				
1% paredrine gtts. 1	75–120	12	1.18	1.50	1.00	7.6
1% homatropine gtts. 7	40– 75	4	1.22	1.37	1.00	9.4
	75–120	10	1.08	1.62	0.87	8.1
1% homatropine gtts. 6	40– 75	5	1.40	2.0	1.00	11.0
1% paredrine gtts. 2	75–120	5	1.22	1.75	0.87	10.3
1% homatropine gtts. 6	40– 75	8	1.38	2.0	1.12	12.0
1% paredrine gtts. 1	75–120	12	1.09	2.0	0.75	9.0
1% homatropine gtts. 5	40– 75	6	1.50	2.0	1.00	9.0
1% paredrine gtts. 1	75–120	12	1.15	1.50	0.75	9.1
1% homatropine gtts. 4	40– 75	28	1.20	2.50	0.75	6.6
1% paredrine gtts. 1	75–120	26	1.35	2.50	0.75	6.8
1% homatropine gtts. 3	40– 75	38	1.26	2.0	0.75	7.6
1% paredrine gtts. 1	75–120	38	1.24	2.50	0.75	7.4

drops have been administered.

Although our studies have shown that the number of instillations has little effect on the production of satisfactory cycloplegia, we believe that for routine practice two drops of 2-percent homatropine are more satisfactory than one drop of 5-percent solution. When only one drop

Our studies also show that the addition of paredrine, whatever the quantity or mode of administration of the cycloplegic drug, does not increase the cycloplegic effect nor hasten the recovery of accommodative function (table 6). In the previously published reports in which paredrine has been recommended as enhancing the

cycloplegia and as diminishing the period of recovery, the results probably were due to the fact that lesser quantities of homatropine or atropine were used in combination with paredrine than in the eyes with which they were compared.

Although our conclusions do not agree with those of other investigators, we believe that they have made a valuable contribution in that they have stimulated a more thorough scrutiny and increased understanding of the cycloplegic effects of homatropine and atropine. All of these observers have stressed the fact that a satisfactory cycloplegia has been obtained with smaller quantities of the cycloplegic, and that the recovery period has been shortened. Our studies would seem to prove that these results were not due to the addition of paredrine, but to the decrease in the quantity of cycloplegic used.

Prangen[9] previously has made a plea that purposeless routine procedures in the administration of cycloplegics be discarded in favor of individualization in each case as to the quantity of cycloplegic necessary. Our own studies and those of others who have experimented with the effect of Benzedrine and paredrine substantiate the importance of this view, and the wisdom of this recommendation. The case can be individualized in this respect only when there is accurate measurement of the range of residual accommodation. This procedure should be carried out in all cases, and reliance should not be placed on a particular formula for a certain number of drops which may or may not produce satisfactory cycloplegia in the individual instance.

It is important to use the minimum concentration of cycloplegic that will produce satisfactory depression of accommodation, in order to diminish the time required for recovery of function of the ciliary muscle. A short period of accommodative disability is an important advantage to the patient and tends to decrease his objection to the use of a cycloplegic.

Summary and conclusions

Detailed studies in a series of 341 cases show that paredrine hydrobromide has no advantage as an adjunct in the production of satisfactory cycloplegia. Neither does paredrine influence the period of accommodative disability following cycloplegia. Paredrine has proved to have some value in producing mydriasis in conjunction with euphthalmine in aged patients.

These studies have also shown that satisfactory cycloplegia can be produced with minimum quantities of homatropine and atropine, and that smaller quantities have an advantage in shortening the period of accommodative disability. The quantity of cycloplegic used should be individualized according to the patient's age and accommodative function, and not administered by a blanket formula.

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CONCERNING THE CHAMBER ANGLE

III. A CLINICAL METHOD OF GONIOMETRY

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Present-day interest in the functional importance of the chamber angle, especially in glaucoma, has stimulated these studies of a clinical method of measuring the angle of the anterior chamber.

Many studies have been made of the depth of the anterior chamber from the corneal apex to the lens or iris plane. None, however, have indicated the relationship between these values and the acuity of the chamber angle. The most commonly accepted values of anterior-chamber depth may be tabulated as follows:

Age years	Plantenga-1898[1] mm.	Saunte-1905[2] mm.	Lindstedt-1916[3] mm.	Raeder-1922[4] mm.	Rosengren-1930[5] mm.
40-50	2.93		3.56	3.37	3.35
50-60		3.22	3.213	3.15	3.22
60-70	2.61			3.04	3.17

The methods used to obtain these and other values have varied among the various observers. Saunte used an ophthalmophakometer slightly modified from that of Tscherning.[6] Donders used a microscope, focusing first on the corneal vertex and then the pupillary pigment border. Lindstedt utilized the principle of measuring the interval of Sturm of an astigmatic beam focused simultaneously on the cornea and anterior lens capsule. Raeder similarly focused the anterior corneal surface and pupillary border simultaneously but used a principle whereby the field of the microscope was divided into upper and lower halves. By means of a system of totally reflecting prisms, one half of the field was focused on the pupillary border while the other half brought the anterior corneal surface into sharp view. Rosengren used Lindstedt's method and measured the depth of the chamber in 810 normal eyes and in 104 glaucomatous eyes. He found that in

the majority of the latter group the chamber depth compared favorably with the normal. Most of the eyes with shallow chambers were in patients with incompensated glaucoma.

We used the Ulbrich drum, mounted on a Zeiss slitlamp microscope (Czapski), to measure the apparent anterior-chamber depth in 100 normal eyes of patients over 55 years of age, in 100 eyes with compensated glaucoma, in 15 eyes with incompensated glaucoma, and in 24 eyes with glaucoma capsulare. Because of difficulty in focusing both the corneal apex and the pupillary border in the same microscopic field under the magnification used (×22), and because the values were to be employed only in a comparative sense, the margin of the pigment border of a three-millimeter pupil was used as the zone of measurement of the cornea as well as of the iris. The anterior corneal surface was focused in the zone of specular reflection in each case. The micrometer drum was then turned to such a position that the stationary index pointed to zero. The milled head of the microscope was then moved toward the iris border. When sharply focused, the drum readings were made. Several trials were made in each case. Since only the virtual image of the iris formed by the cornea-aqueous optical system is seen, the apparent depth values were corrected, using keratometric values and Hartinger's[7] formula. A corneal-thickness value of 0.5 mm. was used. This method, though not so accurate as those of Lindstedt and Raeder, has value in a comparative study such as is described here.

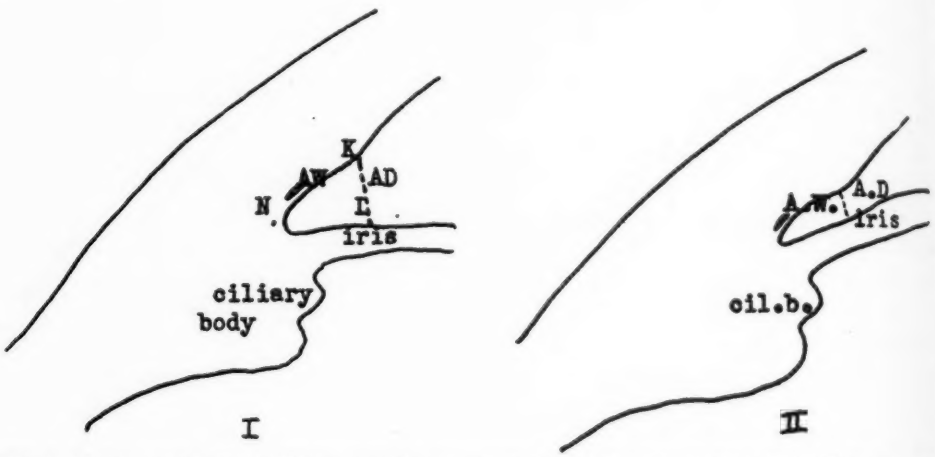

Fig. 1 (Gradle and Sugar). Diagrammatic representation of the apparent angle depth in eyes with normal (I) and shallow (II) chambers. A.W., angle wall; A.D., apparent angle depth.

The average comparative values for the 100 normal eyes of patients over 55 years of age was 2.10 mm. (ranging between 1.72 and 2.63 mm.); for 16 eyes with incompensated glaucoma with tensions (at time of measurement) varying between 9 and 40 mm. Hg (Schiötz), 1.39 mm. (0.91 to 2.03 mm.); for 24 eyes with glaucoma capsulare (tensions between 10 and 43 mm. Hg, average 24.5 mm.), 2.11 mm. varying between 1.82 and 2.56 mm.; and for 100 eyes with compensated glaucoma (tensions between 15 and 60 mm. Hg, average 28.8 mm.), 2.13 mm., ranging between 1.50 and 3.29 mm. The latter group was divided according to age. Of 24 eyes in patients between the ages of 29 and 49 years, the average

comparative chamber-depth value was 2.19 mm., while that of 76 eyes in patients between the ages of 50 and 84 years was 2.11 mm. The range of values in the above groups is more significant than their averages (see table 1). In the patients with compensated glaucoma, the values were the same as in the normal in 79 of the 100 eyes. In the remaining 21 the chamber depth was shallower than in our normal group. Some of the latter undoubtedly belong in the group of chronic incompensated glaucoma, although this could not be determined from the evidence at hand. The tensions in both groups averaged 29 mm. Hg (Schiötz), ranging between 15 and 60 mm. in the former, and between 18 and 60 mm. in the latter group.

TABLE 1

COMPARISON OF THE COOPERATIVE CHAMBER DEPTH AND APPARENT ANGLE-WALL DEPTH

	Tension (Schiötz) mm. Hg	Chamber Depth average mm.	Chamber Depth range mm.	Apparent Angle-Wall Depth average mm.	Apparent Angle-Wall Depth range mm.
100 normal eyes		2.10	1.72–2.63		
16 eyes incompensated type of glaucoma	av. 23 range 9 to 40	1.39	0.91–2.03		0–0.1
100 eyes compensated type of glaucoma	av. 28.8 range 15 to 60	2.13	1.50–3.29	0.57	0.1–1.5
24 eyes glaucoma capsulare	av. 24.5 range 10 to 43	2.11	1.82–2.56	0.85	0.3–1.4

The chamber-angle depth was measured in all glaucomatous eyes by a new gonioscopic method, utilizing the Koeppe gonioscopic contact glass and a micrometer graticule etched in tenths of a millimeter in one of the ×5.5 microscope oculars. With the angle of observation as nearly parallel to the plane of the iris as possible, the length of an imaginary line between the apparent end of Descemet's membrane (line of Schwalbe) and the opposite perpendicular point on the iris is measured directly in millimeters. This value is then corrected by using the graticule-microscope magnification factor and the 1.3 diameter magnification value for the contact glass. By reference to figure 1, it can be seen that the imaginary line KL is measured.

As previously reviewed by one of us (H. S. S.[8]), the chamber angle consists of the angular space bounded by the iris root and the scleral wall. Its lateral or external wall contains all the landmarks necessary for gonioscopic observation. Of these, only the line of Schwalbe, corresponding to the apparent ending of Descemet's membrane and the beginning of the corneoscleral trabeculum, is important for goniometry.

The values obtained for this perpendicular side of the triangle KLN are not absolute anatomic values, but are measurements modified slightly by the foreshortening of the obliquely seen space and by the necessity of viewing the angle from somewhat above the iris plane. As the plane of the iris nears the posterior corneal surface and the depth of the

chamber decreases, the external wall of the chamber angle KN is seen from a more oblique angle and becomes further foreshortened. As the chamber becomes still shallower, the external wall KN is gradually concealed by the advancing iris so that the distance KL becomes less and less and finally appears only as an immeasurably thin line.

to know the absolute chamber depth. Comparative measurements of the angle acuity may be utilized as indications of progress toward shallow-angle glaucoma. Furthermore, measurements of angle acuity may in due course of time prove to be a valuable adjunct in the evaluation of provocative tests.

Translation of the measurements of

TABLE 2

COMPARISON OF CHAMBER DEPTH, CHAMBER VOLUME AND ANGLE DEPTH IN 10 SELECTED CASES*

	Comparative Anterior-Chamber Depth mm.	Anterior-Chamber Volume c.c.	Angle Depth mm.	Tension at Time of Puncture (Schiötz) mm. Hg
1	1.82	0.26	0.7	24
2	2.0	0.26	1.0	31
3	2.14	0.20	0.7	19
4	1.83	0.24	0.5	32
5	1.50, deep in periphery	0.265	0.7	32
6	1.6	0.17	0.1	21
7	1.5	0.10	0.1	24
8	1.3	0.10	0.1	24
9	1.5	0.165	0.1	24
10	1.5	0.11	0.1	21

* The chamber-depth values are for the pupillary-border zone. Miotics were used in every case.

The values for the distance KL, measured and corrected as described, were as follows:

In incompensated glaucoma—from 0 to 0.1 mm.

In compensated glaucoma—from 0.1 to 1.5 mm. Average 0.57 mm.

In glaucoma capsulare—from 0.3 to 1.4 mm. Average 0.85 mm.

The higher values were found in myopic eyes.

Although there is a gross relationship between the depth of the anterior chamber at the border of a 3-mm. pupil and the width of the aperture of the chamber angle (KL), it is not always close nor constant. Much depends on the individual anatomic variations of the iris-root insertion. From a clinical standpoint, it is much more important to know the acuity of the angle of the anterior chamber than the distance KL into terms of angle acuity is, of course, only approximate and practical only in eyes with shallow chamber angles, where the distance measures 0.3 mm. or less. The average length of the external wall of the angle of the anterior chamber (KN) for all practical purposes may be assumed to be a straight line which in fixed microscopic sections has averaged 0.8 mm.[8] This distance (KN) is taken as the hypotenuse of the right-angled triangle NLK. The side opposite the angle under consideration is the distance measured with the graticule-microscope (KL). Thus a simple mathematical calculation shows that when KL has a value of 0.1 mm., the angle KNL (at the angle of the anterior chamber) has an acuity of 7 degrees, and when the distance KL measures 0.3 mm., the angle has a value of 23 degrees. The anatomic varia-

tions of the iris insertion preclude the acceptance of these values as other than approximations.

With the kind aid of Dr. Peter Kronfeld, the comparative chamber-depth values were checked against the chamber volume in 10 cases. After measurement of the depth, the chamber was punctured with a 27-gauge needle and the aqueous removed as described by Kronfeld,[9] who found the average volume of the normal anterior chamber to approximate 0.24 c.c. His measurements were carried out in a large series of cases of hyperopic and emmetropic eyes in individuals between the ages of 20 and 40 years. The relation between the relative chamber-depth value and the absolute chamber volume is seen in table 2.

Conclusions

1. We have described a new procedure, which we have termed goniometry, for measuring the acuity of the angle of the anterior chamber in the living eye.

2. We have found that the acuity of the angle of the anterior chamber bears a gross but inconstant relationship to the depth of the anterior chamber and is of greater value from a clinical standpoint than is the latter.

3. Incidental to this study, the findings of Rosengren that a majority of cases of compensated glaucoma have chambers of normal depth, is corroborated.

4. Clinical goniometry may be of value in following shallow-angle types of glaucoma and may indicate such normal eyes as should be watched for further evidences of impending glaucoma.

5. It is suggested that goniometry be utilized in studying and evaluating provocative tests in preglaucomatous eyes.

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HOMOTRANSPLANTATION OF PRESERVED CORNEA*

An experimental study

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The use of the cornea of cadavers as material for keratoplasty has received a great deal of attention in both the scientific and the lay press. With the renewed interest and research in keratoplasty in the past decade the possibilities of utilizing the eyes of cadavers have been investigated more thoroughly. The necessity for such investigation was urged by Filatov,[1] who saw a wide field for optical keratoplasty in the Soviet. According to his calculations, there were in the U.S.S.R. 238,000 blind, of whom some 45 percent were blind due to leukomas. Included in this category was blindness due to trachoma, smallpox, blennorrhea, diseases of the cornea, and syphilis, without regard to other pathological changes that may occur in these diseases apart from the corneal involvement. By way of comparison with conditions in our own country, so that one may have some concept of the actual need for corneal tissue for homotransplantation, table 1 is presented. In it are compared the incidences of blindness from various causes in the United States[2] and in the Soviet.[1]

TABLE 1

Data on blindness in the U.S.S.R. and in the United States

Blindness	U.S.S.R.	U.S.A.
Total number of blind	238,000	117,000
Causes of blindness	percent	percent
A. Disease	80.2	54.4
1. Trachoma	20.64	1.6
Glaucoma	21.8	5.4
2. Diseases of cornea	8.43	1.2
3. Smallpox	10.63	.7
4. Blennorrhea	3.54	3.4
Diseases of optic nerve	4.06	6.9
5. Syphilis	3.62	.5
Diseases of uveal tract	1.56	.9
Diseases of central nervous system	1.19	.6
General diseases	4.83	15.7
B. Congenital blindness	2.41	7.4
C. 6. Injuries	6.56	16.5
D. 7. Causes unknown	10.82	6.8
Blindness from leukomas of all etiology (estimated)	45% (approx.) 117,000 cases	19% (approx.) 22,000 cases (Sum of 1–5, plus ½ of 6 and 7)

It is apparent that the number of individuals who may profitably avail themselves of optical keratoplasty in the United States is much smaller. It should be remembered also that about 20 percent of all blindness occurs in individuals past 65 years of age. Such patients would rarely be chosen for keratoplasty. A large

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percentage of the blind who have corneal disease also have complications in the uveal tract or in the retina which will militate against keratoplasty; nevertheless, one might estimate that if only half of the people blind from corneal opacity are eligible for operation there are still some 10,000 who might be benefited by the operation.

It is recognized that the obtaining of suitable corneal tissue for transplantation is sometimes difficult. One cannot control Destiny so that a donor and a recipient will present themselves at the same time. In our own clinic we have found, over a period of four years, that many more eyes with useful corneas were enucleated, than there were suitable cases for transplantation. It became merely a matter of waiting for a few weeks to three months before a proper eye for enucleation presented itself: Nevertheless, disregarding the legal and sociologic complications of obtaining the eyes of the deceased, it must be acknowledged that the eyes of cadavers would afford a constant, ready supply of tissue for transplantation. It is important, therefore, to know definitely whether such tissue may be used with as great a chance for success as may the cornea from a recently enucleated eye.

Filatov[3] has determined that the eyes of cadavers removed within a few hours after death may be preserved as long as 56 hours, at temperatures of 4°-6°C., and still retain the viability of the cornea. The results of 95 corneal transplantations, using such material, were reported in 1936. Eighteen (19 percent) of the series resulted in transparent grafts. In five cases (5 percent) vision was improved to 1/10 or better. A striking feature of this report is that the five most successful grafts were made with corneal tissue that had been preserved as described for the relatively short period of 24 to 36 hours. Nižetić[4] described a series of 24 transplants, using cadavers' corneas that had been kept 24 hours or less. Five of the grafts were considered "clear" (21 percent). Castroviejo[5] has used the cornea of the dead fetus for transplantation, with encouraging results in three cases in which the cornea was used 24 hours after death. In a fourth case, in which the cornea was kept for 61 hours, the graft became nebulous. This case, however, was an unfavorable one. It is to be regretted that the enthusiasm of some investigators in this field has led to the publication of conclusions not entirely warranted by the facts. In a recent publication, Vasserman,[6] reviewing the work of Filatov, states that, "the conserved cornea of the cadaver is the best material for corneal transplantation. The transplantation of cadaver's cornea gives transparent taking of the cornea in 58 percent as compared with 20 or 28 percent with respect to the living eye." This is obviously a misstatement of the facts. It is now well established that the success of a corneal transplant depends chiefly on the condition of the cornea into which it is placed,[7] and very little on the source of the graft, as the above-stated conclusion would lead us to believe. It may be said that, in general, the better results have been reported by operators who have used fresh tissue (Castroviejo,[8] Thomas[9]). Imre,[10] discussing a paper on corneal transplantation by Löhlein, stated that he had had better than 50 percent successful results using only living cornea. Elschnig, many years ago came to the conclusion that in corneal opacity resulting from interstitial keratitis about 80 percent of transplants were successful. When one considers the differences in selection of cases, in classification, and in technique, and the great variety of complications that may be present in an unrestricted clinical series of corneal opacities, the invalidity of such

a comparison is evident. It would seem that the only way to arrive at any trustworthy conclusions regarding the relative merits of immediate and delayed transplantation of cornea is through the medium of a controlled animal experiment.

Experimental

Such an experiment was undertaken in the Surgical Research Laboratory of Stanford University School of Medicine. The rabbit has in the past proved to be a reliable index as to what may be expected in the human in corneal transplantation.[11] A series of 33 animals was given partial penetrating transplants into normal corneas from eyes that had been enucleated at death and preserved for periods of 24 to 52 hours. The eyes were kept in sterile bottles containing citrated blood from the donor animal at a temperature of 4°C., as described by Filatov. The blood was used instead of Ringer's solution, which had been employed in several preliminary experiments, because the former appeared to keep the epithelium in a somewhat healthier state. Half of the 33 corneal tissues were preserved for 24 hours and half for 48-52 hours, the latter depending on convenience. On removal from the refrigerator, the eyes were placed in Ringer's solution at room temperature where they remained for approximately one hour before the graft was excised. The graft and its bed were cut with the twin knife, keratome, and scissors after the method of Castroviejo.[8] A section of cornea, 4 mm. square, was used. The graft was secured by means of two figure-eight sutures anchored in the cornea at each side of the square and passing across the graft to prevent its outward displacement. This method has been described by Thomas. The sutures were removed on the fifth day. The pupil was kept constantly dilated by means of atropine and adrenalin.

The results obtained in this series were compared with the results in a control series of 28 rabbits in which homotransplants were performed with corneal tissue removed within 20 minutes after death. This control series was undertaken first so that any advantage depending on improvement in technique would weigh in favor of the series of delayed transplants. All operations were performed under identical conditions and with identical pre- and postoperative treatment. Three operations were excluded from the control series: One in which there was a traumatic dislodgement of a clear graft during suture removal and two in which exogenous suture infections occurred. Two operations in which suture infection occurred followed by infection of the graft were excluded from the series of delayed transplants. Final inspection was made after six months. In the rabbit this is an ample period to allow for clearing. Several doubtful cases were observed longer.

Appearance of cornea preserved 24 hours. The globe is very soft. The cornea presents a bluish haze, through which iris and pupil may be seen fairly distinctly. The epithelium shows very fine, almost microscopic stippling, but is quite lustrous. The thickness of the cornea is increased to almost 1 mm. When the initial incision is made, the cut edges retract slightly because of the edema. When the cornea is perforated with the keratome there is noted a slight tendency for separation of Descemet's membrane from the stroma. This tendency hampers dissection with the scissors somewhat and almost invariably results in the leaving of a tiny tag of Descemet's membrane at the corners of the graft.

Appearance of cornea preserved 50 hours. The cornea has a bluish-gray haze through which iris and pupil are indistinctly visible. The surface is dull, and

there is diffuse stippling when fluorescein is applied. The thickness varies between 1 and 1¼ mm. when the eye is first removed from the refrigerator. After standing at room temperature for one-half hour the swelling decreases somewhat and there is somewhat greater transparency. The tendency to separation of Descemet's membrane is much more marked than in cornea kept for 24 hours and hampers dissection considerably. The increased thickness of the cornea likewise makes accurate dissection with scissors more difficult. When the free graft is placed in position there is usually a difference in level of 0.25 to 0.5 mm. between the surface of the graft and surface of the cornea. The sutures must be tied much more loosely than usual to avoid pressing into the elevated graft.

Results. In the control group of 25 operations 52 percent resulted in grafts which were transparent to a degree that the fundus could be seen through the graft. This was accepted as the criterion for success. If one third of the transplant showed this degree of transparency it was considered successful. In 4 of the 13 clear grafts there were single, narrow, anterior synechiae. These did not result in vascularization or opacification of the transplants even after six months.

In the entire group of 31 delayed transplantations (24 to 52 hours) there were 10 clear grafts (32 percent). Considerable difference was noted between results obtained with cornea that had been preserved 24 hours (fig. 1) and tissue preserved 48 hours or more. In the former group of 16 operations, 7 resulted in transparent grafts. In the latter group of 15 only 3 resulted in satisfactory grafts.

Discussion

Cause of Opacification. The causes of opacification in corneal transplants in general have been very adequately worked out by Castroviejo[11] and by Thomas.[12] The primary causes may be summarized briefly as follows: (1) poor nutrition of the graft; (2) infection; (3) incarceration of iris in the operative wound; (4) vascularization.

Secondary to these causes are a number of complications: Poor adaptation of the margins of the graft to the host's cornea, marked early edema of the graft, corneal fistula, pressure from sutures on the surface of the graft, suture infection, folding of Descemet's membrane.

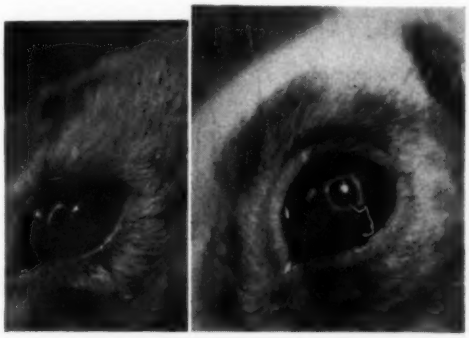

Fig. 1 (Fine). Grafts from corneas preserved for 24 hours. The transplants are perfectly transparent and avascular.

The chief factors that operated to produce opacification in the transplants of preserved cornea were the poor nutrition of the graft and vascularization. The edema of the corneal tissue at the time of transplantation undoubtedly interferes with proper diffusion from the margins of the host cornea through the graft. In a transplant with fresh tissue there is frequently a transient edema of the graft during the first three or four days until proper diffusion is established. If, in addition, there is originally an edema of the graft the interference with nutrition must be that much greater. As a result of the increased thickness of the cornea after preservation, accurate coaptation of the layers of the graft with the layers of the

host cornea is difficult, so that the surface of the graft may be higher than the surrounding cornea, as previously mentioned. In four of the experimental animals it was observed that while the posterior layers of the transplant became united and were relatively clear, the epithelium, Bowman's membrane, and superficial stroma showed increasing edema of the operations, disappearing by the fifth or sixth day. In the operations with cornea preserved 48 hours there was in every case moderate to marked swelling of the graft, so that the corneal sutures tended to press into it, even though they had been tied very loosely at the time of operation. The sutures were removed as early as possible for this reason (4 to 6

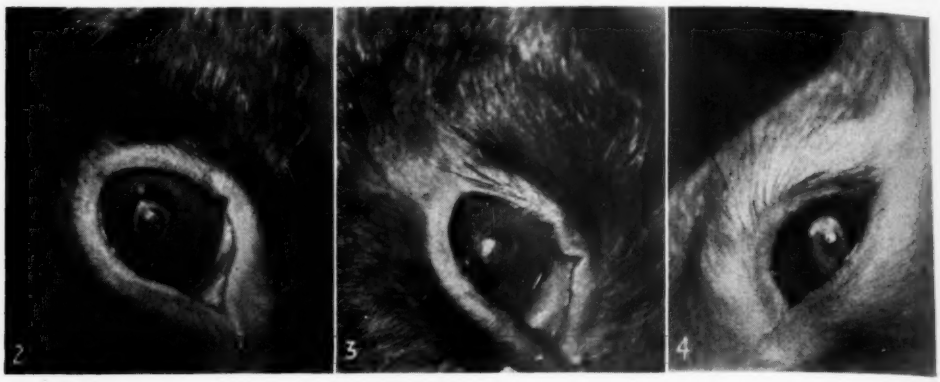

Fig. 2 (Fine). Graft from cornea preserved 48 hours. There is a superficial central scar the formation of which was preceded by a prolonged edema of the epithelium, with elevation of the surface of the graft above the level of the adjacent cornea. The transplant is avascular. The posterior layers are clear.

Fig. 3 (Fine). Graft from cornea preserved 50 hours. The upper half of the graft is transparent after six months. The scarring of the lower half is mostly superficial, the underlying stroma being only faintly nebulous. Two small superficial vessels enter the scarred area from the limbus.

Fig. 4 (Fine). Graft from cornea preserved 50 hours. There is a thin layer of connective tissue on the posterior surface of the graft while the stroma and epithelium are quite transparent. In preparing the transplant, Descemet's membrane tended to split away from the stroma even under the slight pressure from the keratome point. As a result, there were several small defects in Descemet's layer of the graft.

during the first few days and finally necrosis. The result was a dense superficial scar, overlying the relatively clear posterior layers of the cornea (figs. 2, 3, and 4).

The increase in edema of the graft during the first few days was much greater in the case of the preserved tissue than in the case of fresh tissue. In the control group, a slight, transient edema of the graft occurred in about two thirds days). The swollen state of the graft often lasted 10 to 12 days and was followed by loss of epithelium.

Vascularization, when it occurred in grafts performed with fresh tissue, appeared as a result of adherence of the iris to the posterior surface of the corneal wound, or actual incarceration of the iris. In contrast, vascularization of grafts of preserved cornea was for the most part superficial and proceeded from the

limbal loops as a result of degeneration of the superficial layers of the graft. Interpretation of this observation must, however, be modified by the fact that a greater incidence of iris adhesions was encountered in the control group—eight (four of them in transparent grafts) as compared with five in the series of delayed transplants.

The results of the experiment are summarized in table 2.

TABLE 2

RESULTS OF EXPERIMENTAL TRANSPLANTS

Type of Graft	Number of Operations	Number Transparent Grafts After 6 Mo.+ (Fundus visible) (through graft.)	Successes (percent)
Cornea preserved 24 hours in donor's citrated blood	16	7	44
Cornea preserved 48–52 hours in donor's citrated blood	15	3	20
Cornea preserved 24–52 hours (total preserved)	31	10	32
Cornea transplanted immediately after enucleation	25	13	52

CONCLUSIONS

The results of a limited, controlled experiment suggest that corneal tissue used immediately after removal of the eye or the death of the animal is superior for optical keratoplasty to tissue that has been preserved for more than 24 hours at low temperatures. Cornea that was preserved for 24 hours gave results which approached those obtained with "fresh" cornea, but the preservation of cornea for 48 hours or more definitely jeopardized the chances for successful transplantation.

The reported results of optical keratoplasty in man likewise indicate that superior results have been obtained with "fresh" material. However, the possible invalidity of these statistics has been indicated.

Until more conclusive evidence of the superiority of preserved cornea for keratoplasty is forthcoming, the conservative surgeon will choose to use fresh tissue, if it is available, or tissue preserved for a minimal length of time. The experiences of surgeons in other branches, and the precepts of physiology and pathology will support his choice.

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AN INHERITED EYE DEFECT IN THE GUINEA PIG

Report of further anatomic studies

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Experimental results

Functional-activity study of the angle of the eye. In order to determine the functional activity of the cells in the angle of the eye and in the spaces of Fontana in relationship to inert material injected into the anterior chamber, Berlin blue in aqueous solution and diluted India ink were used. The substances were forced into the anterior chamber until there was a distinct clouding.

One guinea pig (no. 29) so injected with Berlin blue was destroyed in one hour, and sections were made of the anterior segment of the eye. Particles of Berlin blue were found in the anterior chamber, the posterior chamber, and in the epithelial cells of the iris.

Guinea pig no. 30 with a right-eye defect of number 3 severity, and left eye apparently normal was similarly injected and destroyed in one-and-one-half hours. Particles of Berlin blue were found in the anterior chamber, in epithelial cells of the iris, and in the cells of the walls of the spaces of Fontana of the right eye. The left eye had been removed under anesthesia one hour after the injection. The results for it paralleled the findings in the normal eye (no. 29) which was taken one hour after the injection.

One other normal guinea pig (no. 31), injected intraocularly with Berlin blue, was destroyed after five-and-one-half hours; and two normals (nos. 436.1 and 318.1) similarly injected with India ink were destroyed at 15- and 24-hour intervals. All three showed particulate matter in the cells lining the spaces of Fontana. In numbers 31, 436.1, and 318.1 there was a slight amount of the particulate matter in the spaces of Fontana.

Results of observations on the eyes of normal embryos

Twenty-five days. The corneal anlage was fairly distinct from the anterior epithelium of the lens. Cells of the anterior epithelium of the cornea and those of the epidermis were indistinctly marked and formed two to three layers. The surface cells had about the same shape as had the deeper polyhedral epithelial cells. Melanophores were confined to the choroid and retina.

There was a depression at the level of each end of the retinal anlage, which indicated the location of the future fornix conjunctivae.

A mesenchymal layer continuous with the sclero-choroid mesenchyme extended for some distance deeply to the corneal epithelium and projected into the space

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Part I of this study, including the bibliography, appeared in the preceding (September) issue of the Journal.

between the lens and retinal anlagen. The cell bodies stained deeply. In the deeper part of this layer there were some capillaries.

Twenty-six days. The cells of the anterior epithelium were somewhat more distinct than were those of the 25-day specimen. A few of the surface cells had become flattened and their nuclei were elongated with their longer axes parallel to the surface. The deeper cells appeared more definitely cuboidal.

The mesenchyme of the substantia propria was largely cellular, a few fibers here and there forming primitive trabeculae. In the majority of the sections it was four to five times as thick as the epithelial layer.

In sections of some eyes of this-aged embryo there was a distinct anterior chamber, but the posterior endothelium was not a complete layer. In its position were isolated thin polyhedral cells. There was slight hemorrhage into the anterior chamber of one eye.

The choroid and sclera were not differentiated.

Thirty-two days. The superficial layer of anterior epithelial cells was more flattened than in 26-day embryos. The epithelium of the fornix was not folded. Melanophores were not present in the conjunctival nor in the corneal epithelium, but were plentiful in the choroid and iris.

Trabeculae of the substantia propria were about one half the thickness of that of the adult. The trabeculae were distinctly fibrillar. The trabeculae of the angle of the anterior chamber were quite large and close together while as a consequence the spaces of Fontana were very small.

Forty-five days. The superficial layer of the anterior epithelial cells of the cornea contained, quite largely, flat cells with elongated nuclei. Occasionally, just beneath this outer layer, a larger cell with a large nucleus could be seen. This type was more numerous near the limbus. A single layer of plump columnar cells intervened between the superficial layer and the substantia propria. These cells had large vesicular nuclei. There were thus but two well-defined layers in this series.

Near and at the fornix conjunctivae the surface cells became more rounded. There was some folding of the epithelial layer with ridging of the superficial part. The deeper portion of the epithelial layer at this point appeared to contain more cells. At the turn, the epithelial layer contained two or three layers of flattened cells which soon became modified to the type typical of the palpebral conjunctiva.

A few melanophores were found in the anterior epithelium at the limbus. They had the appearance of having developed *in situ,* since they did not appear to be related to any similar neighboring cell group.

The trabeculae of the substantia propria contained prominent nuclei and much resembled the mature type of trabeculae. At the limbus the superficial trabeculae were lacelike and fibrous. This portion appeared to be continuous with the adjacent sclera.

The posterior endothelium appeared to be quite completely developed.

A few spaces of Fontana were discernible in the superficial part of the angle of the anterior chamber, while the deeper portion was composed of quite dense fibrous tissue and was cellular.

Sixty days. The cornea as a whole resembled that of the mature eye.

The anterior epithelium was composed of four to six layers of cells, the superficial layer of which was made up of flat cells. The deeper cells resembled those of the mature epithelium. At the fornix conjunctivae the superficial cells changed

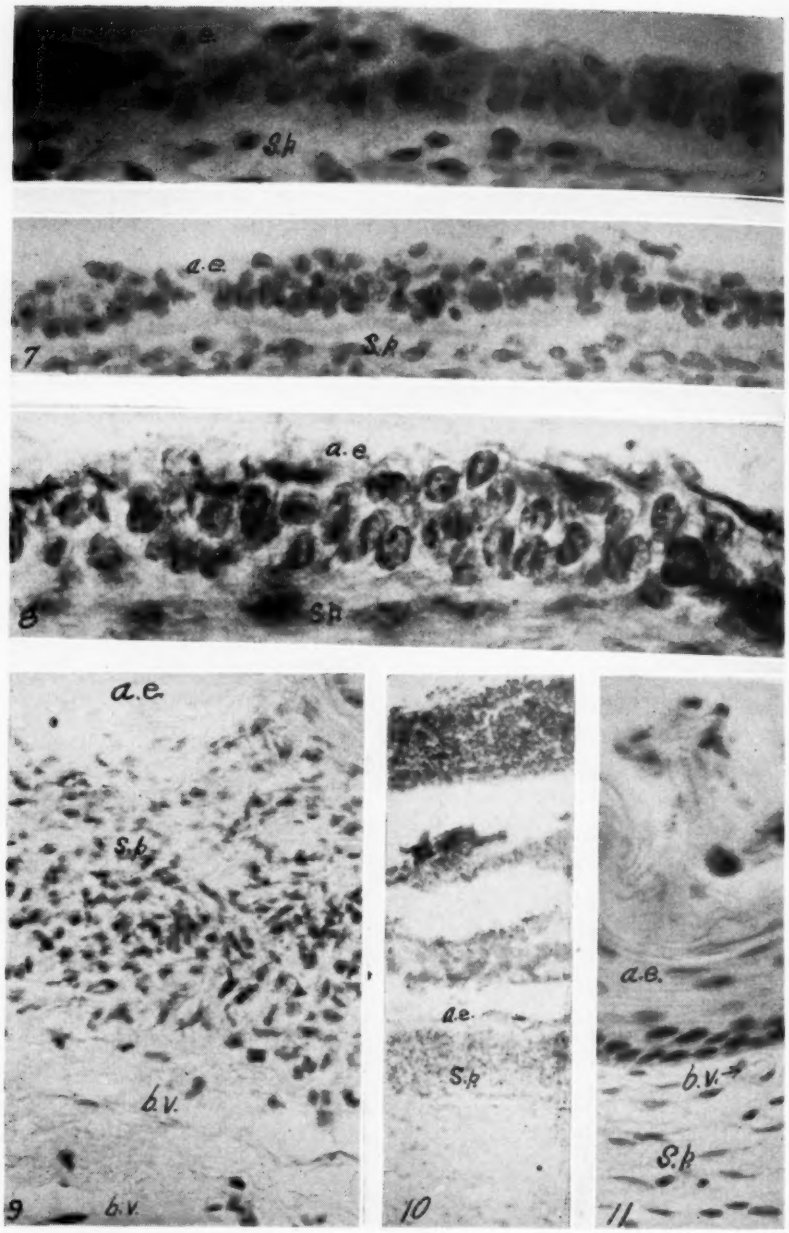

Plate 2 (Foust).

Fig. 6. Section of defective cornea of guinea-pig embryo, aged 29 days. Hematoxylin and eosin (× 800). a.e., defective area in anterior epithelium; s.p., superficial portion of substantia propria.

Fig. 7. Section of defective cornea of guinea-pig embryo, aged 30 days. Hematoxylin and eosin (× 400). a.e., defective area in anterior epithelium; s.p., superficial portion of substantia propria.

Fig. 8. Section of defective cornea of guinea-pig embryo, aged 45 days.

from a flat type to rounded cells. There were more cell layers at the fornix. The whole epithelial layer was folded at this angle. Melanophores were few and confined to an area near the limbus. The substantia propria of the cornea very closely resembled the mature type. Nuclei were, however, more distinct and more plentiful. A few capillaries were found near the limbus.

The trabeculae of the angle were still quite cellular.

RESULTS OF OBSERVATIONS ON THE EYES OF EMBRYOS FROM DEFECTIVE PARENTS

Twenty-one days. Surface cells of corneal anterior epithelium and of adjacent epidermis—some appeared edematous, others flat and scalelike.

In some sections there was some cellular débris on the corneal epithelium, which appeared to be continuous with the surface cells.

Twenty-six days. On one of the corneas of this series, at the limbus, was a mass of cellular débris which contained some blood cells. This appeared to be adherent to the superficial cells. A few similar smaller masses were present here and there on the adjacent epidermis of the fetus, so it would appear that the disturbance was not confined to the corneal epithelium and hence might not be pertinent to the problem under consideration. No melanophores were found in the epithelium. The fornix notches were wider.

Twenty-nine days. Narrow area on the surface of the anterior epithelium of the corneas showed some erosion, and some débris was present (fig. 6, a.e.). One eye had a similar involvement of the anterior corneal epithelium equal to about one third of the area of the cornea (fig. 6, a.e.).

Thirty days. Superficial cells (fig. 7, a.e.) of anterior epithelium of the corneas definitely more edematous than for the 29- or 32-day normal.

There was an edematous area between the anterior epithelium and the substantia propria (fig. 7, s.p.). A similar area was not found in the 29-day normal.

Thirty-seven days. Most of the cells of the anterior epithelium appeared polyhedral. Those at the superficial surface were quite largely edematous.

Forty-five days. Several areas on the surface of the anterior epithelium of the corneas were eroded and edematous. In one area the cytoplasm of the basal cells presented a washed-out appearance (fig. 8, a.e.).

Forty-seven days. The anterior epithelium of the corneas was characterized at this stage by thickening. The palpebral conjunctiva was also thickened. Some of the superficial cells of the anterior epi-

Hematoxylin and eosin (× 800). a.e., defective area in anterior epithelium; s.p., superficial portion of substantia propria.

Fig. 9. Section of defective cornea of guinea pig, aged 24 hours. Hematoxylin and eosin (× 400). a.e., area free of anterior epithelium which had been eroded from the surface of the substantia propria; s.p., superficial portion of substantia propria presenting marked leukocytic infiltration; b.v., capillaries in substantia propria.

Fig. 10. Section of defective cornea of guinea pig, aged 24 hours. Hematoxylin and eosin (× 100). a.e., remnant of anterior epithelium with three layers of epithelial débris superficial to it; s.p., superficial portion of substantia propria, infiltrated with leukocytes.

Fig. 11. Section of defective cornea of guinea pig, aged two weeks. Hematoxylin and eosin (× 400). a.e., anterior epithelium with marked disturbance of superficial layers; s.p., superficial portion of substantia propria; b.v., capillary in substantia propria near epithelium.

thelium were broken up, some were edematous. In some limited areas débris was present; there was also edema of the deeper adjacent epithelial cells. Some edematous cells were so swollen that their outlines were indistinct.

Sections of corneas were stained for keratin with negative results.

Fifty-five days. Near the vertex of the corneas a considerable area presented a change which was peculiar to a particular series of embryos (B402.2E). The substantia propria was edematous, nearly doubled in thickness, and the nuclei did not take the hematoxylin stain.

The posterior endothelium on some portions of the modified substantia propria was broken down into débris.

In some portions, and especially in one cornea, the anterior epithelium was greatly thickened. The superficial cells in this particular one were edematous. There

TABLE 1

TABULATION OF OBSERVATIONS ON DEFECTIVE GUINEA PIGS

Guinea Pig	Age	Degree of Disturbance	Changes in Anterior Epithelium					Changes in Substantia Propria		Type of Mount
			Edema	Erosion	Thickened	Debris on Surface	Pigmentation	Vascularization	Leukocytosis	
20	24 hrs.	R, L 3	+	+		+	Slight	Very Slight	Definite	Sections
22	24 hrs.	R, L 2	+	+	+	+	Marked	Definite	Definite	Sections
B527.1	Adult	R-3 L-1	+	+	+ +	+ Slight	Slight	Definite Definite	Definite Definite	Sections
B569.1	11 days	R-3 L-3						Marked		Whole
21	14+days	R-3 L-3	+ +	+ +	+ +	+ +	+ Extensive	Extensive Marked	+ 	Sections
B365.1	Adult	R-0 L-3			 +			Definite		Sections
B382.1	Adult	R-3 L-0				+		Many Lymphocytes in palpebrae		Sections Poor Sections
B391.1	Adult	R-3 L-3	 +	+ Slight	 +	 +		Large vessels Definite	 +	Sections Sections
B402.2	Adult	R-3 L-3	+ +		 +		Some	Definite	Marked	Sections
B420.1	Adult	R-? L-3	 +			+	 Marked	 Definite		Sections Poor Sections
441.1	Adult	R-3 L-3	+ 	 +				Marked Marked		Sections Sections
B442.1	Adult	R-0 L-3	+ +	+ +	 +	 +		 Definite	Lymphoid tissue in fold of fornix Some	Sections
B451.1	Adult	R-3 L-3					Some Much			Whole
B451.2	Adult	R-0 L-3	 +	 +		 +	 Marked	 Definite	 Considerable	Sections
B474.1	Adult	R-2 L-3	 Slight			 +				Sections
B481.1	Adult	R-0 L-2	+ +	 +	 +	 +		Definite Definite	 Definite	Sections
B484.3	Adult	R-+ L-+	 +			+		Definite Definite		Sections
B526.1	Adult	R-? L-?						Very Slight Slight		Whole

was a bulging of the superficial part of the substantia propria into the base of the thickened cellular mass.

Sixty days. There were changes here and there in the anterior epithelium of the corneas. In some areas the superficial cells were edematous, the cytoplasm being pale and indistinct. The nuclei of some cells were unstained with hematoxylin, in some other cells vesicular. In some areas the entire epithelial layer appeared to be edematous.

Subconjunctivally, near one fornix on the bulb, the capillaries were filled with leukocytes. The capillaries in the substantia propria near the limbus were somewhat more numerous than in the normal.

Experiment on functioning of nervi vasorum of the conjunctiva

In order to determine if the vasa nervorum of the conjunctivae of the affected eyes were functioning, an experiment was conducted in which vaso-constrictor and vaso-dilator substances (adrenalin-chloride solution, 0.1 percent; lactic acid, 1 percent) were used.

Two guinea pigs with characteristically normally functioning conjunctivae and lacrimal apparatus and typically normal exophthalmos were used as checks. One eye was used as a check while into the other was instilled the testing substances. In one case 1 drop of the adrenalin-chloride solution was instilled into the conjunctival sac and the resulting constriction of the blood vessels characterized by paling was noted at varying time intervals. The conjunctival sac of the test eye was then washed with aqueous 0.85 percent sodium-chloride solution. Then 1 drop of 1-percent lactic acid was placed in the conjunctival sac and the consequent reddening of the conjunctiva and injection of blood vessels were noted. The procedure was reversed on the other test guinea pig.

From the results observed, it was believed that the responses, which appeared to be typical for the substances used, were evident enough to serve as tests for the particular functioning of the abnormal eyes.

Three mature guinea pigs with abnormal eyes ranging in defectiveness from moderate to severe were used. The degree of the severity of the defect was arbitrarily designated: 1, for least severe; 2, for moderate severity; and 3, for most severe. This method was used for referring to the severity of defectiveness throughout this paper. The more severely affected eye of each guinea pig was used. The gross changes in the affected eyes have been described by Whitlock (1935). In addition to the changes given by him, there was marked enophthalmos unless the palpebrae were swollen, in which case there may have been exophthalmos.

The same procedure was followed for the defective eyes as for the normals. In two cases the lactic acid was used first, while in the other case the adrenalin-chloride solution was used first. In all three of the cases studied the responses compared very favorably with those in the normal eye.

Thus it would seem that the blood-supply control was not at fault in affected animals.

Discussion

In comparing the structure of the normal embryonic eyes with that of the descriptions given in the literature, there appeared to be no marked deviations. The distinctness of the anterior chamber had become quite apparent in the 26-day embryo. Harman and Prickett (1932) had described the lens vesicle as beginning to separate from the corneal anlage at 18 days.

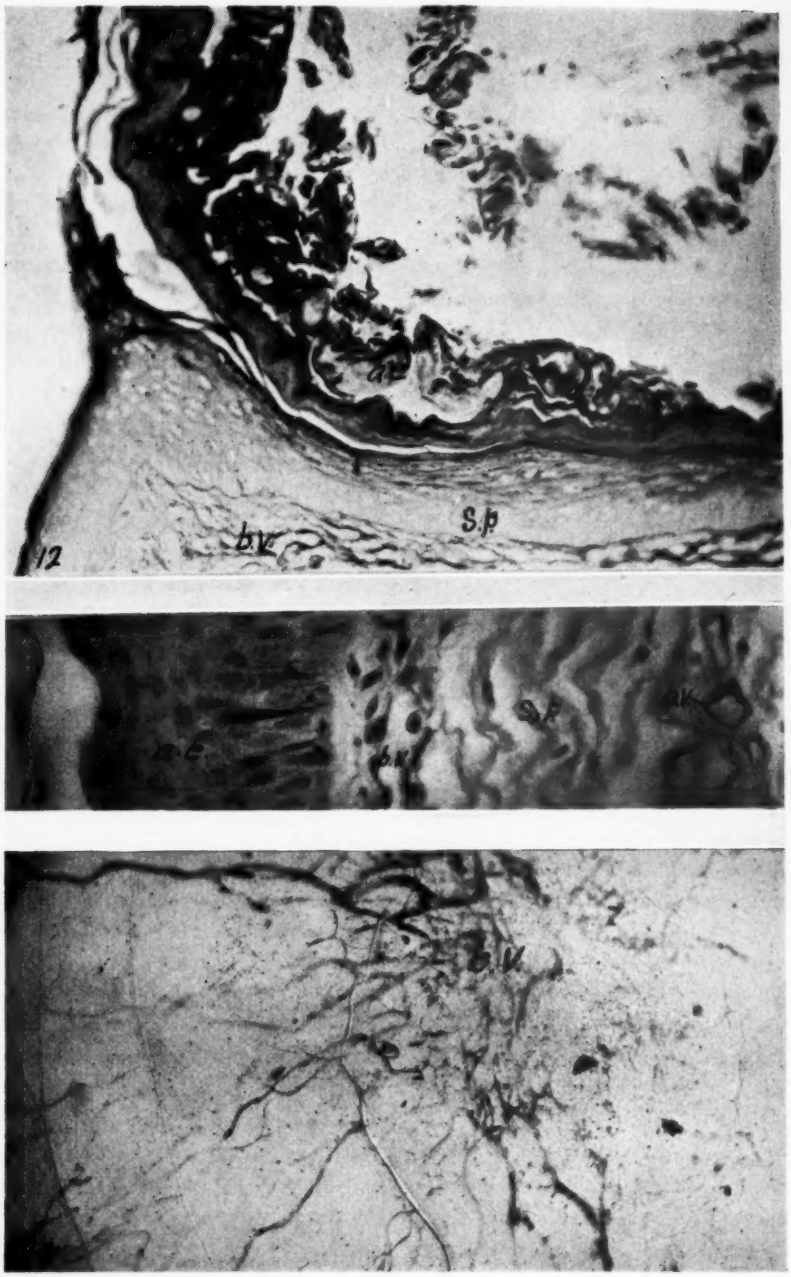

Plate 3 (Foust).

Fig. 12. Section of defective cornea of guinea pig, aged 2 weeks. Hematoxylin and eosin, understained with hematoxylin (× 200). a.e., anterior epithelium, a cone-shaped process of epithelium which often remained after partial sloughing of the surface layers is shown; s.p., superficial portion of substantia propria; b.v., capillary.

Fig. 13. Section of defective cornea of guinea pig, adult. Hematoxylin and eosin (× 400). a.e., anterior epithelium, somewhat edematous and presenting

In the 25-day embryo, the anterior epithelium of the cornea was composed of two to three layers of indistinct cells. In the later stages studied there was a flattening of the surface cells but no marked increase in number until in the 60-day embryo there had developed an anterior epithelium which resembled that of the adult cornea. In the 45-day embryo, the large cells with large nuclei in the anterior epithelium were thought to be cells similar to those "ellipsoidal" and "club-shaped" cells described by Stricker (1873) and Schaffer (1922) and referred to in the literature review on the anterior corneal epithelium. Melanophores were first observed in the anterior epithelium of the cornea of embryos of 45 days. These, because they were not related to similar contiguous groups of cells, might be considered to have arisen *in situ*, thus adding evidence to the idea of the ectodermal origin of melanophores of Strong (1902), Percival and Stewart (1930), Peck (1931), Ramon-Cajal (1933), Du Shane (1938), Pillat (1933a), and Dorris (1939).

A subepithelial layer of mesenchyme was present in the cornea of the earliest embryo studied. Hensen (1866), Laguesse (1923, 1926), Studnicka (1913), Knape (1909), Hagedoorn (1937), Mann (1928), Wolfrum (1903), Rabl (1900), Grosser (1934), Ayres (1879), and Hertwig (1899) have variously described the development of the substantia propria. The question of origin is not under consideration here so much as the changes that occurred between the early appearance of the mesenchymatous layer and the appearance of the adult type of tissue. The substantia propria corneae was observed to change from a cellular tissue in the 25-day embryo to that of the adult type in the 45-day specimen. Some fibers had appeared in the 26-day embryo and there was from that time onward an increase of fibers and of trabeculae in the substantia propria. Laguesse (1923, 1926), Hagedoorn (1937), Knape (1909), and Hertwig (1899) have described in considerable detail the process as being substantially the same. The spaces of Fontana were small in the 32-day stage while the trabeculae were correspondingly large. This relation was maintained up to 60 days. Speciale-Cirincione (1917) has described the formation of the lacunae as having occurred by the separation of cells, of what he termed the "endothelial circle," by the penetration of liquid.

The structure of the cornea of the guinea pig was given in the earlier paper by Whitlock (1935) on the problem being considered further in this paper. The literature corresponds closely with his description. Especially should be mentioned the absence of an anterior elastic membrane as referred to by him and by Ellenberger (1906), Lightbody (1867), and Rubert (1914). The avascularity of the cornea of the guinea pig coincided with that of other animals (noted by Graves, 1936 and Frey, 1875); however, in some animals (according to Frey, 1875; Leydig, 1857; Lightbody, 1867; Stricker, 1873; Lodemann, 1917; Ruedeman, 1933), capillary plexuses were found at the periphery of the substantia propria of the cornea and extended centripetally varying distances from the lim-

sections of processes of melanophores; s.p., superficial portion of substantia propria, edematous; b.v., capillary.

Fig. 14. Portion of whole mount of defective cornea of a guinea pig. The cadaver had been injected intravascularly (common carotid artery) with a colored gelatin mass. Unstained (× 30). b.v., blood vessels in the substantia propria at the vertex corneae. The relation of these vessels to the vessels at the limbus is quite evident on one side of the photograph.

bus. Whitlock (1935, figs. 1 and 2) observed the same thing in the eye of the guinea pigs of the stock studied in this work. In this connection reference is made to the literature review on the absence also of the canal of Schlemm (Swindle, 1937; Troncoso and Castroviejo, 1936; Maggiore 1917; and Whitlock, 1935).

In the experiment in which Berlin blue in solution and diluted India ink were injected into the anterior chamber, there was no gross movement of the mass from the anterior chamber into the spaces of Fontana; thus it would appear that there was no direct communication between anterior chamber and the spaces. This would corroborate the report of Friedenwald (1936).

In that same experiment, the phagocytic action of the cells in the walls of the spaces of Fontana was observed. Gasteiger (1934) had found reticuloendothelial cells in the conjunctiva, sclera, and uvea.

Some evidence of the defect being considered in this paper could be seen in embryos of 21 days. At 29 days, however, the defect was quite pronounced in the anterior epithelium (fig. 6, a.e.). The degree of change appeared to remain at about this level during the remaining portion of the gestation period as judged from the feti studied (figs. 7-8, a.e.).

Briefly summarizing "The tissue changes" as given by Whitlock (1935), there was a vascularization of the substantia propria of the cornea and a variable amount of melanosis due to varying numbers of "stellate pigment cells in the deeper layers of the anterior epithelium." Varying degrees of disturbance of the anterior epithelium were described. The vascularization was often the only change in the substantia propria; however, there may have been leukocytosis or edema resulting in near obliteration of the fibers.

The further studies, that is, the observations upon the normal developing eye, the changes in the defective eye during development, and the tabulation in table 1 of further observations upon defective eyes of guinea pigs, upon which this paper has been based, add data which corroborate Whitlock's (1935) observations. The effect of the defect on the eye in the living animal is well shown in figures 1, 2, 3, and 4. The melanotic cell observed by Whitlock (1935, fig. 4) had a morphology similar to that given by Laidlaw (1932), Strong (1902), Percival and Stewart (1930), Peck (1931), Ramon-Cajal (1933), Du Shane (1938), Pillat (1933b), and Rubert (1914), who had described it as an irregularly shaped cell with dendritic processes, some of which extended into intercellular spaces.

In figure 13, a.e., may be seen sections of processes which appear to be intercellular. Schaffer (1922) and Fol (1896) too have noted this position of pigment. In the same figure there appears to be some pigment in the cytoplasm of the epithelial cells. Figure 4 of Whitlock's (1935) paper also shows pigment granules in the same locus. Pigmentation of the cornea is not uncommon (Ellenberger, 1906; Bulliard and Champy, 1929; Lightbody, 1867; Fischer, 1905; Lodemann, 1917; Fischel, 1919b; Duke-Elder, 1934; and Ovio, 1927), Duke-Elder (1934) and Lightbody (1867) having found it more marked near the limbus corneae. Whitlock in his figures 1 and 2 shows this pigmentation. Rubert (1914) too reports it in the guinea pig. From one defective specimen (B569.1, table 1) a drawing was made of the distribution of the pigment cells as seen from the surface of a whole mount of a cornea (fig. 5). This was taken from a very defective specimen, as reference to table 1 shows it to have been of grade 3. Along with the epithelial disturbances shown in figures 6,

7, 8, 10, 11, 12, and 13, and those shown in the substantia propria of the same figures and in figure 9, there appears to be an increase in the melanophores. The photophobia (Whitlock, 1935) may be a cause of this proliferation of pigment (Pillat, 1933b). The local disturbance of the corneal tissues may also have been a cause of the excess pigmentation (Comberg, 1934; Steiner, 1923).

Vascularization of the cornea appears to be a phenomenon associated with irritation (Steiner, 1923; Wintersteiner, 1909; Lightbody, 1867; Stricker, 1873; Long, Holley, and Vorwald, 1933; Julianelle and Lamb, 1934; Julianelle and Bishop, 1936; and Julianelle, Morris, and Harrison, 1933). In the material here studied the new vessels were largely in the superficial part of the substantia propria (figs. 9, 11, 12, and 13), although occasionally there were some more deeply located (Whitlock, 1935). Vascularity according to Hirsch (1906) is only found at the vertex of the cornea in pathological conditions. That being the case, the great plexus of vessels shown in figure 14 would give an index to the intensity of the disturbances.

The most marked character of the defect and the first to appear (embryo of 21 days) was the disturbance of the anterior epithelium of the cornea. The macroscopic appearance of the eye thus affected is shown in figures 1 to 4. The opacity and the eroded surface are quite evident. The microscopic picture is shown from that of a slight disturbance in figure 13, to more marked disturbances as shown in figures 9, 10, and 11.

Summary

1. Further studies upon an inherited defect of the eye of the guinea pig are here reported.

2. Observations on development of the normal guinea pig eye at intervals from the 25th day of gestation to the 60th day showed the anterior epithelium to grow from two to three cell-layers to four to six layers of cells. The development of the substantia propria corneae was found to follow the descriptions commonly given.

3. The defect was evident in the 21-day embryo as a slight epithelial disturbance which became pronounced at 29 days.

4. The findings of Whitlock (1935) of abnormal vascularization of the cornea with inflammatory changes in the substantia propria and anterior epithelium and a variable amount of melanosis in the epithelium were confirmed by additional data.

Acknowledgement is made of an allotment by the Graduate College of Iowa State College from the Rockefeller Fluid Research Fund which made possible the undertaking of the studies here reported. The writer is especially indebted to Dr. W. V. Lambert for his coöperation and to the Department of Genetics of Iowa State College for supplying the guinea pigs upon which the observations were made.

A PRESSURE DRESSING*

RAYMOND L. PFEIFFER, M.D.
New York

The pressure dressing has an important place in ophthalmic surgery, for the outcome of an operation may depend upon it. Its successful application requires the same care as the surgical procedure itself, and should not be neglected or left nonchalantly to the assistant. Plastic procedures, exenteration of the orbit, enucleation, and the control of orbital hemorrhage are particular indications for its use.

A pressure dressing should effect immobility of the tissues, remain accurately in position for at least five days, not damage tissues of forehead and scalp, and not be uncomfortable to the patient. The dressing evolved at the Institute of Ophthalmology, which employes a specially designed ear pad, fulfills these requirements and is described in response to many requests.

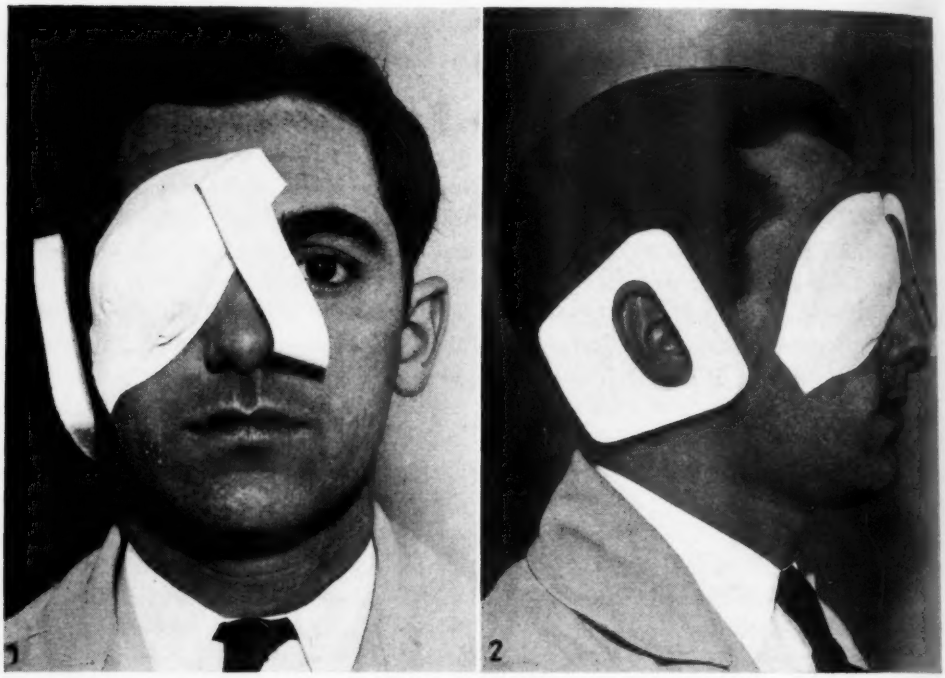

Fig. 1. (Pfeiffer). The ear pad and Wheeler eye dressing in readiness for the application of the roller gauze bandage. A short strip of adhesive, with adhesive surface out, is shown attached to the patch, to be used to secure the gauze bandage in front.

Fig. 2. (Pfeiffer). Side view showing the Wheeler patch and ear pad.

The ear pad (figs. 1 and 2) used in the dressing is cut from one-half-inch-thick white felt, and is designed to protect the auricle and distribute the pressure evenly over the surrounding surface. One side of the pad is wider and is intended to cover the mastoid to protect this promi-

* From the Institute of Ophthalmology of the Presbyterian Hospital.

nence. The quadrilateral shape adapts it to the dressing. It may be washed and used repeatedly. Washing, however, tends to make it larger and lose its shape.*

The dressing is applied in two parts: first, the modified Wheeler patch, and second, a circular bandage is applied with careful attention to the anatomy of the skull.

pulled down. In plastic operations rubberized tissue anointed with vaseline is used on the skin in place of gauze. Then loose gauze sponges are piled on to raise the level above that of the brow. Adhesive plaster strips one inch wide and six inches long, are then placed across the gauze at an angle of 45 degrees with the mid-plane of the face. The first is stretched across

Fig. 3 (Pfeiffer). The dressing after adhesive strips have been applied to the gauze bandage. The pressure turns of the bandage run up over the parietal eminence and are secured by the horizontal turns which also hold the ear pad in place. Note the free position of the left ear.

Fig. 4 (Pfeiffer). Side view of the completed dressing.

The Wheeler patch (figs. 1 and 2). An intermarginal silk suture is first placed in position to insure complete closure of the interpalpebral fissure. A flat two-inch-square gauze sponge anointed with sterile vaseline is placed on the skin of the lids after the upper lid is carefully

to anchor the gauze. The second is placed temporally in a curved manner to tuck in the gauze and hold it securely. The third is placed on the nasal side to hold in the gauze here. Two or three more tapes are lastly placed over the top to pack the dressing firmly. The irregular ends of the strips are cut off with scissors.

Application of roller bandage (fig. 3). For the purpose of securing the bandage

* The felt ear pads may be obtained from the Mechanical Felt and Textile Company, 16 East Twenty-third Street, New York City.

in front, a strip of adhesive six inches long is first attached to the upper end of the Wheeler patch and is turned down over the face with adhesive surface outward. The felt ear pad is placed around the ear on the side of the eye that has been operated on, with the wider portion posterior. The assistant is instructed to hold the patient's head, with one hand under the occiput and the other on the brow. The two-inch roller gauze bandage is started under the occiput and is brought around the side of the ear pad to the eye over the forehead and temple to occiput and around again to secure the pad in position. The next turn is placed low on ear pad, over dressing, and up over the parietal eminence, around occiput, over middle of pad, dressing, and temple, to secure previous turn. The next turn is again low over pad and then, with pressure over dressing, is carried up over the parietal eminence, with the following turn placed to secure the first. These turns are repeated with some going higher than others to place pressure on the dressing from below, and pass high up over the parietal eminence to anchor the dressing up over the opposite ear. The bandage is never twisted. A second or part of a second bandage may be used, but is seldom necessary. The hair should be straightened out above the head and kept out of the dressing as much as possible, especially if the patient is a woman. The roller bandage is next secured in place with adhesive. The tape that was placed with adhesive surface outward is carried up to anchor the front of the dressing. Three six-inch strips are placed on the bandage over the covered eye. Then a 12-inch strip is carried back over the parietal eminence along the margin of the bandage. Another is placed securely around the top of the bandage over the ear pad. A strip of adhesive 6 inches long may be used to pull upward and anchor the dressing above the uncovered ear. A number of 12-inch adhesive strips are then placed in imbricating fashion at various points to cover or nearly cover the bandage.

In place of a roller gauze bandage an elastic bandage may be used. This bandage, however, is not so satisfactory.

635 West 165th Street.

NOTES, CASES, INSTRUMENTS

THE REFLECTING RETINOSCOPE*

JOHN N. EVANS, M.D.
Brooklyn, New York

The modern electric retinoscope does not come up to expectations in precision of results which one might assume when comparing it to the basic form of reflecting ophthalmoscope. It would seem that this is well demonstrated by the fact that in a recent inquiry among ophthalmologists, less than 25 percent used the self-luminous instrument. Instrument cost definitely is not a major factor in accounting for the popularity of the reflecting retinoscope.

The standard reflecting retinoscope has changed little, if any, in design during the past 25 years, although numerous suggestions have been made which, without complicating the instrument, should make it more useful.

To this end, the writer has designed a reflecting retinoscope which brings together well-accepted features. The following tabulation and illustrations will serve to demonstrate its characteristics:

1. A plastic material is employed to insure lightness and permanence of finish.
2. The disc-head is so proportioned that filters or lenses can be mounted before the observation aperture to enhance visibility of pupillary reflex or surroundings. (Presbyopic correction inserted for examiner so that trial-frame markings and adjustments can be observed.)
3. The disc-head is circular in form with elevated projections on the rim at two points for tactile orientation of 90°-0° axis of the instrument as an aid to selection of pupillary reflex axis in cases of astigmatism.
4. Provision is made for interchangeable mirrors to meet choice of examiner: Back and front face silvered mirrors, aperture through silvering only, aperture through entire thickness of mirror, partially silvered mirrors, multiple-lamellae mirrors, concave and plane mirrors, single-striped mirrors (in which the silver is limited to a 3-mm. band across the surface of the mirror thus providing a streak reflex). Analyzing element for use with polarized light.
5. The subject's side of the retinoscope disc-head adjacent to the mirrors is slightly convex and dull in finish, so as to diverge incident light, thus avoiding weak illumination of subject's eye and face and so enhancing comparative intensity of pupillary reflex.
6. The rim encompassing the retinoscope head, about one centimeter in width, is provided so as to form a shallow cup before examiner's eye, thus shielding him from extraneous reflections and permitting secure grasp of the instrument when held in the conventional position.
7. A white band is inscribed in 90°-0° axis on the observer's side of the retinoscope, which can be readily seen by the observer as an aid in determining astigmatic axis.
8. At each end of this band a minute hole penetrates the disc-head. This allows the "source" light to enter as a dim glow and aids in recognizing the axis of the instrument.
9. A deep groove is inscribed, concen-

* From the Research Department, Brooklyn Eye and Ear Hospital.

trically with the aperture on the observer's side of the disc-head which serves as a retaining track in which a white ball rolls freely.

Parallel with this groove, a scale is inscribed in degree markings so that the observer may read off the position to which the ball has rolled when the retinoscope has been rotated (about the line of observation—examiner to subject through the aperture), when the examiner matches the 90°-0° axis of the instrument to the axis of the pupillary reflex.

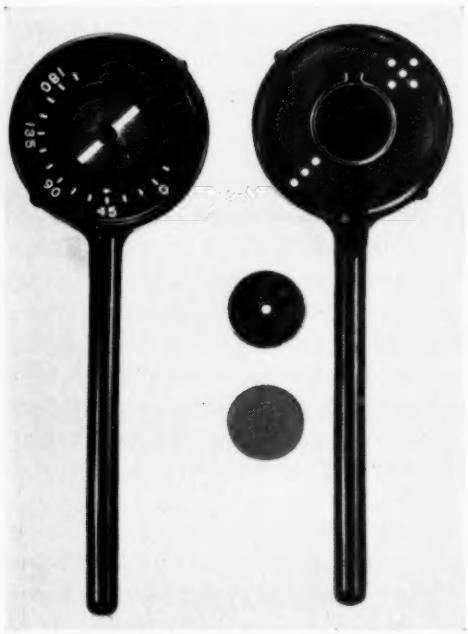

Fig. 1 (Evans). A new reflecting retinoscope.

10. A handle is provided (or omitted if desired) at the 45-degree position so that it will conform to the conventional position used by the examiner in the use of the retinoscope.*

Technique of use: The retinoscope does not depart from the general appearance of the standard instruments, except by the presence of the axis scale and rolling white ball on the examiner's side. There are no movable parts. The instrument is preferably held in the right hand. The examiner grasps the rim of the retinoscope with his index finger on the small protuberance on the rim at the upper end of the white axis line, and his thumb on the lower-rim protuberance. The handle then assumes a position across the palm of the hand and is steadied by the remaining fingers. The examiner holds the retinoscope so that the white axis line remains vertical. He then corrects one meridian of the pupillary reflex in the usual manner. If present, the astigmatic shadow will be visible as a streak. He now matches the axis of this streak with the 90°-0° axis of the retinoscope by turning the retinoscope about his line of observation (aperture as the center of rotation). He can do this with surprising accuracy by comparing the white streak on his (the examiner's) side of the instrument with the pupillary reflex streak, without moving the retinoscope away from his eye, and also by his positional sense through feeling the changed position of index finger and thumb as the wrist bends in rotating the retinoscope. Without further rotation of the retinoscope he now moves it away from his eye and reads the position of the degree scale to which the ball has rolled. This reading is the axis on the subject's astigmatic pupillary reflex.

This instrument has been tested, for approximately one year, by three observers and seems to facilitate the recognition of the axis of the pupillary reflex band.

The writer wishes to thank the National Electric Instrument Corporation for their coöperation in developing this device.

23 Schermerhorn Street.

* The prism "meter-measure" may be added if desired. It is designed to maintain accurate working distance without the necessity of having the retinoscope before the eye.

A SIMPLE METHOD OF LOCALIZING LARGE RETINAL TEARS

A. W. McAlester, 3d, M.D.
Kansas City, Missouri

The apparatus necessary is a soft rubber dropper bulb, and an ordinary finger flash light.

The eye is cocainized, and the pupil is widely dilated. The large end of the rubber bulb is placed over the cornea. When large tears or disinsertions are present, there will be a difference in the shadow that is reflected through the sclera.

The procedure is more satisfactory for tears in the upper part of the globe than in the lower. We have not found it to be of any value in small tears.

The examination obviously is carried on in a dark room.

2003 Bryant Building.

Fig. 1 (McAlester). The small end of the dropper bulb is placed over the head of a small flashlight, and the large end over the cornea.

OLIVARY-TIPPED ANTERIOR-CHAMBER NEEDLE

William Brown Doherty, M.D.
New York

For perfect anesthesia prior to operations on the iris, 3 to 4 minims of a 2-percent solution of cocaine instilled into the anterior chamber will produce an excellent result. A special needle is required, as the ordinary hypodermic needle will engage in the meshes of the iris. The needle is made of gold and silver and can be bent to the desired curve. Gold gives a better contrast against corneal tissue and the expanding, round, bulblike end makes the introduction simple. It is attached to the ordinary Luer-Lok hypodermic syringe. I wish to thank Mr. Oscar Schwidetzky of the Research Department of Becton, Dickinson and Company for his kind assistance in perfecting this needle.

150 West Fifty-fifth Street.

Fig. 1 (Doherty). Olivary-tipped anterior-chamber needle

SOCIETY PROCEEDINGS

Edited by Dr. H. Rommel Hildreth

NEW YORK EYE AND EAR INFIRMARY

Clinical and pathological conference

October 30, 1939

Dr. Sigmond A. Agatston, *chairman*

Simple phlyctenular conjunctivitis with interesting roentgenological findings

Dr. A. J. Elliott reported the case of a nine-year-old boy who first came to the clinic on October 20, 1939, with the complaint that the right eye had been red for two days. On examination of the right eye a small pinkish-white elevation was found, situated in the midst of a hyperemic area 2 mm. from the limbus at the 8-o'clock position. The rest of the conjunctiva was clear and unaltered. Vision was 20/20 O.U. Tuberculin test was negative at 1:10,000 mg.; and positive at 1:1000 mg. The Wassermann reaction was negative.

An X ray of the right eye, taken October 21, 1939, showed a calcium deposit of irregular form and density about 10 mm. wide in the horizontal diameter and 7 mm. in the vertical diameter and about 1 mm. in the anterior-posterior diameter in the anterior part of the globe. Chest plates were normal. Treatment consisted of instillations of powdered calomel into the lower fornix twice a week and cod-liver oil daily by mouth. On October 27th, a further X ray of the right orbit was taken, and no evidence of the previous calcium deposits was found. It was concluded that it must have been calomel in the lower fornix seen in the previous X-ray film. On October 27th the phlyctenule had completely disappeared and the blood count returned to normal.

Discussion. Dr. Wendell L. Hughes said he thought this was an interesting case especially because of the X-ray findings. It was reported that there was calcium in the orbit, and no satisfactory explanation could be given for it. However a second X ray showed the disappearance of the calcium.

Adenocarcinoma of the inner canthus

Dr. Loren Guy stated that this patient, a white woman of 44 years, came to Dr. Hughes's clinic complaining of a growth of the right inner canthus of six months' duration. The growth appeared to be benign, but the patient gave a history of bleeding and a grooved formation in the mass. The tumor was excised on October 9th, and there were no complications. In studying the biopsy, Dr. Brittain Payne found that it was an adenocarcinoma. The sections and pictures were taken to Memorial Hospital, where it was reported that the tumor was malignant. Dr. Guy felt that similar specimens should be sent to the laboratory for microscopic study, since many malignant growths had probably been overlooked and diagnosed as epithelioma.

Case of uveitis and scleritis

Dr. Webb Chamberlain presented a white man of 33 years, who first came to Dr. McDannald's clinic on October 23d with a complaint that there had been progressive loss of vision for 10 days prior to his coming to the clinic. He also saw spots in front of his eye. The patient's wife had noted that there was a swelling on the sclera temporal to the cornea, and

that the eye had been red for six weeks. His vision had become progressively worse, but he had had no pain nor tenderness. The history was negative for lues or tuberculosis. No foci of infection were found. Examination showed his vision to be 20/100 O.D.; O.S. normal. Externally the conjunctiva was injected and there was a nodule about 8 mm. by 8 mm. in size, 1 cm. temporal to the cornea of the right eye. The conjunctiva was movable over this nodule. A dome-shaped swelling, about 2 mm. in elevation, was present. The cornea showed numerous fresh deposits on Descemet's membrane. There were deposits on the anterior lens capsule. The vitreous showed marked haziness, and the fundus was difficult to examine. Far anteriorly on the temporal side, at a point corresponding to the scleral nodule, there was a difference in the color of the fundus reflex. Pigment surrounded this yellowish area.

The nose and throat examination was negative; X rays of sinuses were not significant; dental examination showed one carious tooth, which was extracted. Laboratory study showed the Wassermann reaction to be negative in all three heat fixations, but the Kahn test was 3 plus; Mantoux positive; urine negative; blood sugar 79 mg. percent.

Dr. Chamberlain said that the reason he was presenting this case was to determine whether this was a case of scleritis primarily, or whether it had originated in the choroid involving the sclera secondarily.

Discussion. Dr. Truman L. Boyes asked whether anyone had seen a choroiditis which has spread through the sclera with an episcleral nodule.

Dr. Clyde E. McDannald said that in similar cases which he had seen the patients have had a great deal of pain, but that no pain accompanied this condition.

Dr. Sigmund Agatston said that usually the episcleritis cases are the painful ones, and the tuberculous or luetic cases are not painful. Those of obscure origin are sensitive to touch. From the appearance of the eye Dr. Agatston thought the nodule was most likely a luetic infiltration starting in the sclera and extending into the choroid and involving the uvea. The other possibility is that this is a tuberculous lesion, but Dr. Agatston was more inclined to hold to its luetic origin because of the cumulative appearance and the congestion. He thought that antiluetic treatment should be instituted.

Dr. Robert McClanahan said that Dr. Kohler had suggested incising such a lesion to get a maximum of bleeding, but he was hesitant about following this procedure because of its radical nature.

Angioid streaks

Dr. Herman Elwyn presented a 46-year-old man, who began to notice a loss of vision in the left eye 25 years ago, and last summer noticed reduced vision in the right eye. His vision at present is 10/60 O.D.; the ability to see fingers at 18 inches, O.S. He presented changes of angioid streaks. It is agreed that the changes are caused by degeneration of the elastic fibers in the body and the elastic fibers in the membrane of the eye, with disease of Bruch's membrane. It is most marked in the macular area, and, secondarily, there is a concentration of fluid beneath Bruch's membrane and the connective-tissue membrane. The angioid streak is primarily a constitutional inferiority of the elastic tissue. This disease has a familial tendency.

Discussion. Dr. Wendell Hughes said that only about 75 of these cases have been reported in the literature. The circular grayish-brown pigment streaks surround the disc in an irregular fashion with radiating lines running from the circle to the periphery, particularly toward

the macular region. There was one streak in the right eye, especially noticeable in this case, running nasally from the disc, which was rather broad. These have irregular edges. In this particular streak there were little areas which coincided with the choroidal plexus of the veins through otherwise normal retina. The normal appearance of the fundus gives a clue to the pathology in these cases which are due to loss of elasticity in the lamina vitrea or Bruch's membrane. This brings about tears which tend to separate with the slightest pressure on the eye. They are mostly in the posterior pole of the eye, and become narrower as they spread out from the disc. They resemble tears that might appear in wet tissue paper. The depth of the streaks is always underneath the retinal vessels and in the same level as the choroidal vessels. The pigment that is seen in these tears is the normal choroidal pigment. Where the lamina vitrea is adherent, there is a tendency for hemorrhages to occur when the tears extend into this area. That explains foveal hemorrhages. Verhoeff's case several years ago was one in which the fundus was not examined *anti mortem*, and the case could not be accepted as one of real angioid streak because of this fact.

Dr. Sigmund Agatston said that perhaps the capillaries are diseased, and indirectly affect the nutrition of the elastic fibers which causes them to lose their elasticity. The choroid has to be elastic to allow for stretching, and if the choroid is not elastic, it is apt to tear. The Kuhnt-Junius disease is probably based on some similar condition. Dr. Agatston told of a case that he observed for some time, but which proved to be a retinitis striata.

A CASE OF PROPTOSIS

DR. EDWARD PERKINS presented a three-year-old boy who first came for examination on September 16, 1939, with proptosis of the left eye. The mother stated that about five weeks previously, the child awoke with some swelling of the lids of the left eye, and complained of some pain and rubbed the eye frequently. She thought this condition disappeared in a few days with the use of boric-acid solution. The mother had noticed the left eye being more prominent than the right for the past three weeks. Measurement with the exophthalmometer on the first clinic visit was 12 mm. O.D., 17 mm. O.S. The last measurement, taken about one month later, was the same.

Examination showed the eye to be normal except for the proptosis. The vision was normal. There was no limitation of movement. The pupillary reaction was normal direct and indirect, and the fundus examination has repeatedly been negative. Retinoscopy was normal, being the same in both eyes. Ear, nose, and throat examination was negative, as well as X ray of the sinuses. X rays of the skull, chest, abdomen, and long bones were negative. The blood Wassermann, blood count, and urinalysis were negative, as also were medical and neurological examinations.

This case is presented as one of a unilateral proptosis of two months' duration in an otherwise healthy child, in which, to date, no cause has been found.

Discussion. Dr. Brittain Payne said that this case reminded him of one seen here last summer. The patient, a four-year-old girl, had a small palpable mass near the lacrimal gland. At first it was thought that this was a lacrimal-gland tumor. An exploratory operation was performed, and some tissue removed. Four pathologists examined the specimen—one thought that the condition arose from the nerve fibers of one of the nerves in that vicinity; another said it

was a malignant adenocarcinoma; another opinion was that it was due to the activity of the fibrous tissue, and that this was a fibroma.

At the first dressing the eye was advanced 3 to 4 mm., and it was necessary to suture the lids together and apply a pressure dressing. The patient was sent to Memorial Hospital where an exenteration of the orbit was performed. A large retrobulbar sarcoma was found.

Dr. Payne said that Dr. Perkins's case had been X rayed and no enlargement of the optic-nerve canal was noted. Our impression is that the tumor might be a glioma of the optic nerve.

Dr. Nathan Berger said he had a similar case about 15 years ago. The patient, a boy of eight years, with proptosis of six months' duration, had come to his office. After one year he had a choked disc. An exploratory operation was recommended, but the family refused this. They went to another doctor who removed a fibroma, but in so doing injured the optic nerve. The patient is now blind, but there has been no recurrence of the growth.

Dr. Sigmund Agatston said that since there was no interference with the normal motility of the eye, most likely there was a neoplasm attached to the optic nerve.

Dr. A. A. Knapp said that in a discussion of any growth of the optic nerve with cafe-au-lait spots on the body, Von Recklinghausen's disease should be considered since these coffee spots are present in this disease. Part of the condition is sarcoma. These fibromata do degenerate.

Paul T. McAlpine,
Secretary.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

SECTION ON OPHTHALMOLOGY

October 20, 1939

DR. HENDRIE W. GRANT, *president*

OPHTHALMIA NODOSA

DR. FRANK KNAPP, Duluth, said that Pagenstecher, in 1883, described the first case of ophthalmia nodosa and termed the disease caterpillar-hair ophthalmia. Wagenmann reported such a condition as a case of pseudo-tuberculosis. Later Saemisch used the term ophthalmia nodosum.

There is an early initial stage soon after the caterpillar hairs have entered the eye, with a sensation of a foreign body in the eye. The patient complains of itching, burning, lacrimation, and photophobia. All of these symptoms are aggravated by rubbing of the eyelids. There may be swelling of the lids, pericorneal injection, and edema. On application of fluorescein the cornea stains. The epithelium of the cornea is lost either by penetration of the caterpillar hairs or as a result of excessive rubbing of the eyelids. The discomfort is due to foreign-body irritation and from the chemical irritation.

It has been demonstrated by Karsten that the canal of the hair carries formic acid into the tissues. Gossen believed that the poison is a by-product of the organic material of the caterpillar hair, producing an external poison that is adherent to the hair. In Stargardt's opinion the toxin is a by-product of the decomposition of the chitin brought about by absorption of the hair. It was proved by deSchweinitz that the inflammatory reaction is not due to a secondary bacterial infection.

Some of the caterpillar hairs are not smooth but have fine barbs and spines,

pointing towards the tip of the hair. The penetration of the hairs through the epithelium and their migration is accelerated by this barbed structure.

In the second stage of nodule formation, microscopic study reveals a picture similar to that of a tubercle, with the exception that a hair is seen in the center of the nodule, hence the name pseudotuberculosis. On microscopic section the nodules consist of spindle cells and round cells outside of which there is a capsular formation. Within there are epithelioid cells and giant cells surrounding the hair.

Very few cases of ophthalmia nodosa have been reported in the American literature. The first was by Knapp in 1897. Colborn reported another case in the discussion of Knapp's case. deSchweinitz and Shumway reported a case in 1904. Parker reported a case with extensive review of the literature in 1910. Marlow reported a case of ophthalmia nodosa in 1910. In 1924 a case was reported by Grove. All these are typical cases of ophthalmia nodosa following an injury by caterpillar hairs.

Mrs. W. R. S., aged 35 years, a housewife, was seen on June 30th. About May 30th, she complained of photophobia, lacrimation, and itching in both eyes. In a few days there was rather severe pain. The pain was worse on rotation of the eyeballs. Later the pain radiated to the frontal and temporal regions. All of these symptoms continued to the present but were not so severe as at the onset. On repeated questioning she recalled transplanting flowers that were packed in hairy moss about two weeks before the onset of the eye symptoms. The past ocular history was entirely negative. Vision R.E. was 20/20, L.E. was 20/20. The skin of both upper and lower eyelids was slightly edematous and there was a little hyperemia of the palpebral conjunctiva. On everting the upper lid of each eye the bulbar conjunctiva presented many small yellow nodules from the fornixes to within 3 mm. of the limbus. Some of the nodules were round, others were elongated, and all were situated beneath the conjunctiva. There was no staining of the conjunctiva or cornea by fluorescein. No discharge was present. The conjunctival blood vessels were engorged in the area of the nodules. The lower half of the bulbar conjunctiva was slightly edematous, but no redness was present.

A solution of oxycyanide of mercury 1 to 1,000 was repeatedly injected in the vicinity of the nodules. Only enough to make a small bleb was used in these treatments. These injections were repeated eight or nine times at three-day intervals. Following the injection of oxycyanide of mercury the nodules rapidly disappeared in that area.

The biopsy reports were as follows: ". . . sections show a tissue of granulation with several nodules measuring up to .03 by .15 cm.; those nodules are formed by a tissue of granulation showing numerous giant cells of the foreign body type, lymphocytes, and proliferated fibroblasts. The central part of the nodules is formed by a reddish amorphous material in which faintly bluish staining formations can be seen which suggest broken-up mycelium. Sections stained with Ziehl's solution for acid-fact organisms show nothing of note. The lesion is not tuberculosis, tularemia, or ordinary foreign-body reaction. The lesion represents a granulomatous inflammation of some other etiology, apparently due to a fungus. Cultures made on Sabaraud's agar and on blood agar have remained sterile. Diagnosis: Tissue of granulation from the conjunctiva (fungus infection)," by A. Berdez, M.D.

"The peculiar giant cell reaction is characteristic of fungus lesions, but could also result from a foreign body reaction. There are in the sections some basic-staining fine fibrous structures which look somewhat like mold mycelium which is

distorted or disintegrated, but these structures are not gram positive, as they should be if they were truly mycelium. Similar fibrilla structures may sometimes develop from compressed tissue elements in an inflammatory reaction.

"In short, if this is a fungus infection, the fungi have been so far destroyed by the inflammatory reaction as to become gram negative and not definitely recognizable. It could be a simple foreign body reaction," by Dr. Arthur T. Henrici.

"I feel sure that your case is one of ophthalmia nodosa. Classically this is caused by plant hairs. I cannot recognize any caterpillar hairs in the foreign body tubercles, nor definite plant hairs, but often this is so in such cases. However, I do find a few structures that could be plant hairs, and places in which there may be disintegrating plant hairs. If no recurrence takes place the condition in all probability was due to plant hairs, for when due to caterpillar hairs new tubercles continue to develop for a long period of time due to migration of the hairs. The fact that there is very slight inflammatory reaction around the tubercles seems to exclude fungus infection. The apparent filaments in the centers of some of the tubercles probably have resulted from the cell reactions," by F. H. Verhoeff, M.D.

This case first presented irritation following exposure to hairy moss. Later nodules appeared beneath the conjunctiva. As the lesions did not recur, as is characteristic of ophthalmia nodosa from caterpillar hair, it seems logical to agree with Dr. Verhoeff that this case is one of ophthalmia nodosa from plant hairs.

Anatomical factors related to successful anesthesia of the orbital structures

Dr. John C. Brown, Saint Paul, gave a talk on this subject.

Discussion. Dr. Charles N. Spratt, Minneapolis, asked about complications following orbital injection. He had read of one case in which there was an orbital abscess and knew of one which has never been reported, a cavernous-sinus infection followed by death. It may be of interest to know that in 1884 the surgeon, William H. Halsted of Baltimore, first suggested the use of cocaine for orbital injection, as a prevention of vitreous loss after cataract extraction.

Dr. C. W. Rucker, Rochester, said part of the ophthalmic nerve has always seemed to him to go to the wrong place. He refers to the branch that leaves with the nasal ciliary, passes along the ethmoid sinuses, and emerges to supply the skin over the tip of the nose. He wondered if Dr. Brown through his experience in comparative anatomy, may have some suggestion to offer as to why it should go there. Does its course have anything to do with the development of the bridge of the nose?

George E. McGeary,
Secretary.

COLORADO OPHTHALMOLOGICAL SOCIETY

October 21, 1939

Dr. Melville Black, *presiding*

Congenital absence of puncta

Dr. E. R. Neeper presented the case of Betty M. C., aged nine years, who was seen on account of epiphora and blepharitis. All of the puncta were absent except the left inferior. A rather indefinite opening was found in this location into which a probe could be forced for about one inch. The sac was not entered. Further attempts at probing were contemplated.

Discussion. Dr. Melville Black stated that in this case one must first determine whether a tear sac exists. This may be done by injecting water into the region

of the sac in an attempt to force fluid into the nose. If fluid enters the nose, an incision should be made from the region of the inner canthus into the sac and the opening kept patent by a style until epithelization occurs. He stressed the futility of trying to open the canaliculi.

Dr. William Crisp suggested that the operation of Goar might be attempted.

Conjunctival tumor

Dr. E. R. Neeper presented the case of W. B., aged eight years, who had been under his observation for a year on account of a reddish-brown discoloration of the temporal bulbar conjunctiva. This discoloration had slightly increased in size. Exposure to wind greatly increased the hyperemia of the area. The case was presented for an expression of opinion as to the nature of the discoloration and its treatment.

Discussion. Dr. William Crisp stated that he thought the condition a harmless one, and in the absence of symptoms would leave it alone.

Dr. James Shields and Dr. Melville Black suggested that the area of conjunctiva be excised and subjected to microscopic examination.

Horner's syndrome complicating chest tumor

Dr. V. H. Brobeck presented the case of H. T. C., aged 53 years, because of a Horner's syndrome of unusual etiology. This man was admitted to the Union Printer's Home with general weakness, cough, loss of weight, and pain in the axilla. The left eye showed enophthalmos, ptosis, and miosis with anhydrosis of the left side of the face. X rays showed a mass in the apex of the left chest which has been diagnosed as a Pancoast tumor. This tumor had eroded the upper thoracic vertebrae, accounting for the sympathetic-nerve damage.

Intraocular foreign bodies

Dr. V. H. Brobeck presented the case of G. C., who was struck in the left eye by steel particles while hammering on a steel bit. X-ray examination showed a foreign body in the vitreous just behind the ciliary body. This was removed with a giant magnet through a temporal scleral incision. Further X-ray study demonstrated another foreign body which was also clearly seen by gonioscopy in the region of the trabeculae at the 6-o'clock position. This particle was removed with great difficulty after a partial iridectomy. After the extraction of a traumatic cataract, the corrected vision was 1.0.

Hole in macula

Dr. V. H. Brobeck presented the case of B. L., a college student, aged 19 years. This patient was struck in the left eye by a baseball on May 6, 1939. Four days later the vision was 20/200. The vision has gradually improved but now remains at 20/70. There is a small hole in the macula surrounded by pigment changes.

Ectopia lentis with arachnodactyly

Dr. Fritz Nelson presented a family of four children—three girls and a boy. In three of the children, the lenses were dislocated up and temporally. In the remaining patient the lens was dislocated up and nasally. All of the children show signs of arachnodactyly or giantism or both.

The mother's father had had very poor vision of undetermined cause. The patients' mother has partially dislocated lenses with slight colobomas of the lenses. The father of the children has normal eyes.

Three of the children are wearing aphakic correction while the other sees through his dislocated lenses. In two of the patients the pupils are kept dilated with scopolamine to permit the use of aphakic correction. The vision with

glasses is approximataely 5/10 in these patients. Dr. Nelson discussed in some detail the refractive correction of such cases. He stated that surgery was best avoided unless satisfactory vision could not be otherwise obtained.

Discussion. Dr. William Crisp pointed out the importance of individualizing as far as treatment is concerned. He stated that the use of a strong (2.00-diopter) cross cylinder was useful in the preliminary determination of the astigmatism in cases of this type.

Recurrence of interstitial keratitis following surgery

Dr. Fritz Nelson presented the case of Mr. R. H., aged 68 years, who developed typical interstitial keratitis following an uncomplicated cataract operation. At the age of 13 years this patient had had a severe inflammatory process in both eyes. Slitlamp examination before operation demonstrated old corneal vascularity. On May 25, 1939, an extracapsular cataract operation was performed upon the right eye. Healing was uneventful, and vision of 5/8 was obtained with correction. Six weeks after the operation the cornea became cloudy and vascularized, first in the region of the incision, then generally. Gradual improvement has resulted during the administration of mercurosal. The blood Wassermann reaction was negative. This case was thought to be a reactivation of syphilitic interstitial keratitis following surgery.

Glaucoma complicating retinal detachment

Dr. George Stine presented R. L., a 15-year-old boy, who was struck in the left eye about June, 1938. One year later, on consulting Dr. Stine, a flat detachment of the retina was found. No tears were seen and there was no evidence of tumor. On June 6, 1939, diathermic and galvanic treatment of the upper half of the globe was undertaken. This produced partial reattachment in the upper temporal and nasal quadrants. On June 30, 1939 the nasal half of the globe was thoroughly treated with diathermy and galvanism. The retina became reattached in spots but the macula and lower temporal retina are still elevated. Cystic degeneration of the macula has resulted in a small hole. The tension of 50 mm. Hg (new Schiötz) is not influenced by miotics. Gonioscopy shows some pigment in the spaces of Fontana.

Discussion. Dr. William Crisp stated that he would make some attempt to lower the tension surgically before treating the detachment further.

Bilateral chronic uveitis

Dr. George Stine presented Mrs. D. D., aged 40 years, whom he had first seen in October, 1937, when she had a chronic uveitis of the left eye. At that time there had been cells in the aqueous, keratitic precipitates, vitreous opacities, and a small choroidal exudate. The patient was extremely sensitive to tuberculin and exhibited both a local and focal reaction. Treatment has consisted of gradually ascending doses of B.E. over a period of two years, some local X-ray therapy, and a course of sulfanilamide. The eye is very much better but still not entirely quiet. In October, 1939, an acute choroiditis developed in the right eye. This eye has received some X-ray therapy and the removal of a devitalized tooth and infected gall bladder is contemplated.

Ocular melanomatosis with brain metastasis

Dr. Edward Neeper reported the case of J. W., aged 60 years, who was first seen in October, 1937, because of an iritis of the right eye. This responded well to treatment, but glaucoma later developed necessitating enucleation on March 12,

1938. Dr. E. DeCoursey, of the Army Medical Museum, reported on the eye as follows "Malignant melanomatosis . . . this is a very unusual tumor. It is difficult to determine whether the origin is from the retinal pigment epithelium or from the optic nerve or brain. Indeed if it could be shown that this did not originate in the brain, I believe that it is the first acceptable melanoma arising from the pigment epithelium."

In April, 1939, the patient developed pain in the right side of the head and temporal hemianopsia. A long series of X-ray treatment to the head has controlled the pain but the hemianopsia persists. The optic disc is abnormally white. The patient is now in the hospital suffering from pain in the back, hips, and legs, probably from metastases.

John C. Long,
Secretary.

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KERATOCONUS

One of the most interesting papers read before the Association for Research in Ophthalmology this year was that of Terry and Chisholm on "Keratoconus," which is published in this issue. This disease has always been one of ophthalmology's puzzles as to both nature and treatment. Fortunately it is rare, although the authors believe that it occurs much more frequently, especially in cases of mixed astigmia of large amounts, than is generally suspected. Probably one reason for the inefficacy of treatment is that each physician sees so few of these cases and changes in them are so slow that the individual is often lost from observation, or improvement may be wrongly interpreted as due to effective treatment.

It has seemed to me that an endocrine disturbance was frequently at least partially responsible for the disturbance, especially when associated with malnutrition. Most of my patients have been women, with onset occurring in their twenties. They have tended to be poorly nourished and frequently there was a history of irregular menses. Two of them had cystic ovaries. Two men were definitely hypothyroid and pituitary types. Appropriate treatment for these conditions has seemed to have been of definite benefit in preventing progress of

the disease. However, my cases are too few for purposes of argument and the intention of this editorial is not to discuss them but to refer to the treatment suggested and used by Terry and Chisholm.

No originality is claimed by these writers for the idea of pressure therapy but only for the method of its application. Most ophthalmologists who have employed pressure have done so spasmodically and for brief periods. These authors advocate systematic and prolonged pressure. They state that this treatment "does reduce the deformity in some instances and gives permanent cure of the disease if the pressure is maintained sufficiently long (at least 10 weeks) to allow scar-tissue repair to mature enough to hold the newly attained more or less normal thickness of the cornea."

The authors advise restricting pressure treatment at present to patients who have keratoconus of considerable amount, with reduced vision not much improved by contact glasses. This brings up the subject of the use of contact glasses in this disease and here the contact glass comes into its own. If this type of glass had no other value, its usefulness in keratoconus alone would give it an important place among therapeutic devices. Like many another with whom I have talked, there have been moments when I have been so heartily sick of efforts to fit contact glasses that I have wished that they had never been invented. So often many hours are spent in adjusting them and trying futilely to satisfy oneself as well as the patient; and even after countless attempts it is sometimes impossible to attain success. (Frequently when one succeeds the time spent cannot be adequately paid for.) This reaction usually follows the attempt to supply these lenses, at the earnest behest of the patient, for only a moderate myopia in lieu of glasses, and only for cosmetic reasons. But for kerataconus—"that is another story"!

To improve vision from 5/200 more or less to 20/40 or even better, when other lenses are of almost no help, seems almost magical. Patients in these circumstances are so elated by the improved vision that they are not critical and will make every effort towards coöperation in the fitting and wearing of the lenses. Only today I waited on one of this sort whose life has been made over by the fitting of contact glasses which can be worn for 12 hours.

In the acute type of case, in which there is sudden loss of vision due to apical edema and cloudiness, I have tried with astonishing success the method of X-ray treatment described by Henry Hilgartner, Jr., before the Association for Research in Ophthalmology, a few years ago. Probably prolonged pressure bandage would be valuable in such cases.

Certainly Terry and Chisholm have given us much food for thought and experimentation. Their further reports and those of others who may employ this procedure will be awaited with interest.

Lawrence T. Post.

DIATHERMY PUNCTURE FOR OBSTINATE GLAUCOMA

One has only to look through the eye journals of thirty-five or forty years ago to realize how greatly the surgical treatment of glaucoma has advanced since the days when iridectomy was virtually the only available operation for this disease.

But although the average prognosis in glaucoma has been vastly improved, and although the great majority of glaucoma patients can now escape from the threat of blindness, every eye surgeon encount-

ers a distressing percentage of cases in which all efforts are unsuccessful and the eye goes on to absolute blindness.

It is a familiar fact that early treatment improves the prospect of cure. Too frequently the patient does not come for attention until the disease is far advanced. Some of the neglected cases fail to respond to every surgical as well as every medical procedure. On the other hand, some of the more acute cases which receive prompt attention display a malignant and obstinate tendency to progressive deterioration. Thus every well-planned proposal for a new surgical mode of treatment deserves careful consideration and trial.

Three years ago Vogt (see American Journal of Ophthalomology, 1938, volume 21, page 84) described the use of diathermy puncture for such cases. Some of our readers will already have familiarized themselves with a more recent report by Vogt on the same topic ("Cyclodiathermy puncture for glaucoma," Klinische Monatsblätter für Augenheilkunde, 1939, volume 103, page 591; and subsequently, in English translation,* British Journal of Ophthalmology, volume 24, page 288). But most of our readers are likely to be unfamiliar with this later essay, and they may welcome fuller mention of it than is practicable in our Abstract Department.

Vogt's procedure consists essentially in the making of a larger number (as many as one hundred or more) of minute diathermy punctures of the sclera in an area between the ora serrata and the anterior margin of the ciliary body. The method presents certain risks, but it is credited with affording relief in many cases in which iridectomy, cyclodialysis, and filtration operations have failed.

(The operation has been given a trial in a few otherwise desperate cases at the Massachusetts Eye and Ear Hospital,** with at least some appearance of success. It has probably been tried also in other parts of the United States.)

"Cyclodiathermy puncture" is said by its inventor to be entirely free from the danger of sympathetic inflammation which has been attributed to filtration operations. Its occasional risks, especially with imperfect technique, include intraocular hemorrhage and injury to cornea or lens. To avoid these hazards, Vogt insists that the diathermy needle shall have a stop and shall be no more than 0.5 mm. in length from stop to tip; that its diameter shall be from 0.16 to 0.18 mm.; and that the most anterior punctures shall lie at least 2 to 2.25 mm. outside the corneoscleral limbus.

A conjunctival incision is made near the insertion of the inferior rectus muscle and is continued as far as the insertion of the internal and external recti. The inferior rectus is anesthetized, the sclera laid completely bare, and its insertion narrowed by short lateral cuts (but without completely severing the tendon). With a current of about 60 ma., multiple punctures with the diathermy needle are made throughout a belt of sclera 2.5 mm. wide, ranging from the insertion of the internus to that of the externus, and within the boundaries previously defined. The needle is inserted vertical to the sclera and is kept in position from a half to one second. The punctures may be placed 0.25 to 0.50 mm. apart. A minute escape of vitreous is not only inevitable but desirable. After making one hundred or more punctures the conjunctiva is sutured. The operation may be repeated several times if necessary.

Vogt is disposed to attribute the permanent hypotensive effect of the proced-

* Although unfortunately without acknowledgment of the original place of publication.

** Personal communication from Dr. George A. Filmer.

ure to reduced secretory activity of the epithelium of the ciliary body. He believes this impression is supported by the fact that in some of his successful cases, three years after operation, the intillation of atropine or homatropine failed to cause pathological increase of tension.

Vogt's method may well be tried by American ophthalmologists in those apparently hopeless cases which have failed to yield to more customary surgical remedies. The Swiss author has found its action favorable in all the cases in which high tension had produced obliteration of the anterior chamber, and in which the lens and iris were pressed against the cornea. The reëstablishment of a deep anterior chamber makes other intraocular operations, such as iridectomy or cataract extraction, again possible.

W. H. Crisp.

BINOCULAR VISION WITH OBLIQUE ILLUMINATION

At the March meeting of the Section of Ophthalmology of the Royal Society of Medicine, Williamson-Noble told of how a brown dot on the cornea was supposed to be a foreign body. But when it could not be removed, the slitlamp showed it was a spot of old pigmented tissue. He points out that with binocular stereoscopic vision, its position could have been obvious at once. His paper entitled "Binocular loupes" tells how he has secured a practical instrument, a modification of the Zeiss telescopic binocular loupe.

In 1896 there was described in the Ophthalmic Review (p. 129), and in the Transactions of the American Ophthalmological Society (p. 174), a simple binocular magnifying lens, giving a magnifying power of 8 to 15 diameters, for examination of the cornea, iris, and lens, by oblique illumination. Later there was described in the Annals of Ophthalmology and Otology (v. 5, p. 935), an arrangement of lenses and prisms in two tubes, supported before the eyes by frontal and occipital plates, connected by a steel spring. This leaves both hands free for manipulation, or operation on the eye. It has been extensively used in America, being more practical and more convenient than the slitlamp biomicroscope.

There can be no question as to the value of binocular vision, with appropriate magnification, for the diagnosis and treatment of conditions in the anterior segment of the eye. Private patients in the doctor's office furnish the best clinical material for the study of modern ophthalmology. The ophthalmoscope and the binocular magnifier have opened a great field for scientific study. The biomicroscope, with illumination furnished by the slitlamp of Gullstrand is a valuable instrument for original investigation. But the binocular magnifier is more convenient and is often needed for operations on the anterior segment of the eye. It is not so well known and generally used as it should be, but it belongs in the equipment of every ophthalmologist.

Edward Jackson.

BOOK NOTICES

LA FOTOGRAFÍA DE LAS MEMBRANAS PROFUNDAS DEL OJO. By Manuel de Rivas Cherif. Paperbound, 75 pages, illustrated. Published by La Casa de España en Mexico. 1940.

This is a short monograph on the photography of the deep tissues of the eye, containing a two-page bibliography of 40 references, 15 drawings illustrating the different cameras and the principles involved, and 37 photographs, for the most part of the fundus in different conditions. The monograph opens with a de-

scription and explanation of the underlying principles of ocular photography, a résumé of several cameras utilized for the purpose (that is, Dimmer, Werheim Salamonsohn, Muñoz Urra, and Nordenson), and a brief discussion of color photography. The monograph contains a number of photographs of the fundus, all taken with Nordenson's apparatus, but unfortunately the reproductions leave much to be desired. The advantage of the monograph is the simplicity and conciseness with which the subject is presented, and its main failing rests in the relative fewness of photographs and their improvable reproduction. L. A. Julianelle.

CORRESPONDENCE

Trichloracetic acid for postoperative hypotony

Editor,
American Journal of Ophthalmology

Dear Sir:

In the June, 1940, issue of the American Journal of Ophthalmology, page 692, Dr. Hans Barkan describes the use of the Shahan thermophore in hypotony of the eyeball as the result of the Elliot trephining operation. To accomplish the same result he describes, I use trichloracetic acid applied to the conjunctival bleb. While I do not recall any mention in the literature of this method of relieving hypotony following the Elliot trephining operation, no claim of originality is made. Anyone who has witnessed the highly satisfactory trichloracetic-acid treatment of cystoid cicatrix following a cataract operation will readily appreciate how this method of treatment is applicable to the condition described by Dr. Barkan.

The technique is quite simple. The conjunctival bleb is anesthetized and a concentrated trichloracetic-acid solution is applied to the bleb by a sharpened matchstick or toothpick. This procedure is repeated several times, usually three or four, and at intervals of one to two weeks. The bleb is thus transformed into one much flatter and more dense, and the tension in the eyeball rises due to greater restriction of the distribution and absorption of the accumulated fluid. Some judgment, of course, must be exercised, as it seems possible by this treatment to overcorrect the hypotony and defeat the purpose of the trephining operation.

Very truly yours,
(Signed) Sam N. Key,
Austin, Texas.

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP

ASSISTED BY DR. GEORGE A. FILMER

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is only mentioned in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology.

1

GENERAL METHODS OF DIAGNOSIS

Cogan, D. G. **A self-luminous Placido disc.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 914-915.

Cotton, J. M., and Rosin, S. **Measurement of the structures of the fundus.** Arch. of Ophth., 1940, v. 23, June, pp. 1146-1156.

After reviewing the literature the author presents a method for making measurements on the fundus with the standard monocular Gullstrand ophthalmoscope fitted with a Lobeck ocular which makes use of the heliometer principle. The inaccuracies of Lobeck's original method have been corrected in the author's method by applying a formula that takes into account the optical properties of the instrument and the refractive error of the individual eye. Measurements by this method are probably reliable to 0.01 mm.

J. Hewitt Judd.

Mikhailov, A. X. **Binocular loupe with illumination.** Viestnik Opht., 1940, v. 16, pt. 4, p. 254.

A description of a binocular loupe to which is attached a light globe.

Ray K. Daily.

Nisbet, A. A. **Keyhole diaphragm for the ophthalmoscope.** Amer. Jour. Ophth., 1940, v. 23, July, pp. 809-810.

Schlichting, Hans. **The evaluation of the tuberculin test of Mantoux with human and bovine tuberculin in eye diseases, with special consideration of threshold reaction.** Klin. M. f. Augenh., 1940, v. 104, April, p. 401.

By intracutaneous injections of human and bovine tuberculin in 87 patients with eye affections suspected of being tuberculous and in 87 patients free from active tuberculosis, the weakest tuberculin concentration producing reaction was ascertained. (1) There was no essential difference in the effect of human and bovine tuberculin. (2) The reactions of those suspected of tuberculosis did not essentially differ from those of controls. (3) The proven tuberculous patients were predominantly negative and only reacted positively to higher tuberculin concentra-

tions. The intracutaneous tuberculin reaction therefore is not apt to play a role in the clarification of the tuberculous etiology of eye disease.

C. Zimmermann.

Sugar, H. S. **Concerning the chamber angle. 1. Gonioscopy.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 863-866.

Walker, C. B. **Use of the Purkinje figures as test for separated retina and other intraocular pathology.** Amer. Jour. Ophth., 1940, v. 23, July, pp. 803-804; also Trans. Amer. Acad. Ophth. and Otolaryng., 1939, 44th mtg., p. 399.

2

THERAPEUTICS AND OPERATIONS

Cavara, V. **Sulphamide therapy in ophthalmic practice.** Boll. d'Ocul., 1939, v. 18, Aug., pp. 597-630.

From his own experience and reports in the literature the writer concludes that sulphamide therapy is used with advantage in blennorrhagic conjunctivitis of newborn and adults, in streptococcic ocular infections, and in the treatment of trachoma and its corneal complications. Sulphamide-resistant cases are mentioned, as well as cases of idiosyncrasy to the drug, and some of disturbances of skin, blood, and optic nerve. The purity and dosage of the drug have some bearing on the genesis of these disturbances. (Bibliography.) M. Lombardo.

Chance, Burton. **A clinician's experience with sulphanilamide.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 900-904.

Diban, P. A. **The use of antireticular cytotoxic serum in some ocular diseases.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 132.

Goat serum injected with spleen and bone-marrow extract was used in general medicine with the object of increasing the physiologic function of the reticulo-endothelial system. The author used this serum in 65 cases of various ocular diseases, in 50 of which the results were gratifying.

Ray K. Daily.

Dimitry, T. J. **Vacuum massage of the eyeball.** Arch. of Ophth., 1940, v. 23, May, pp. 926-929.

The author discusses conditions in which ocular massage is of benefit, and describes a simple device for massaging the eye. It consists of three parts: a flashlight, a 2-c.c. syringe, the upward movement of the plunger being produced by a spring, and a third part made of a plastic material which is carved so that one side is a cup and the other a high convex lens. When the light is turned on the ocular tissue can be viewed under the magnification provided in the cup. Intermittent pressure is accomplished by alternate pressure and release of the plunger.

J. Hewitt Judd.

Ivanov, E. I. **The use of nonmatching blood transfusion in ophthalmology.** Viestnik Opht., 1940, v. 16, pt. 4, p. 204.

Transfusion of unmatched blood in general medicine was introduced by Spasokikotzki in 1933. Its action is directed toward the inhibition and arrest of allergic manifestations. Ivanov tried intravenous injections of small quantities of unmatched citrated blood in 35 cases of various ocular diseases. The quantity of blood used was 5 c.c. for the first dose and 10 c.c. for the second dose. The reactions to such injections varied in intensity and depended on the quantity injected, the rapidity of injection, and the constitutional characteris-

tics of the patient. A detailed report of the 35 cases shows that the best results were obtained in allergic diseases and diseases of the anterior ocular segment. Acute infections responded better than chronic. In some cases the disease was arrested following one transfusion. Ray K. Daily.

Jahnke, W. **Does local anesthesia aid or hinder the process of ocular healing?** Graefe's Arch., 1940, v. 141, pt. 1, pp. 106-108.

The author briefly discusses the literature on the use of anesthetic solutions in the conjunctival sac and their effect on healing. Prolonged local anesthesia of the cornea and conjunctiva has a deleterious action upon ocular healing because of the dangers of drying, injury, and impaired vasomotor responses. Herpes zoster ophthalmicus and keratitis neuroparalytica illustrate the harmful effects of abnormal trophic impulses. The author concludes with the statement that no patient should be given a local anesthetic in oily solution or in ointment for home use. He also emphasizes the fact that the physician is liable for an eye injury resulting from the use of such medications.

C. A. Perera and U. Ollendorff.

Krasnov, M. L., and Dozortzeva, P. M. **Investigations on chinolin no. 31, a new antimalarial preparation.** Viestnik Opht., 1940, v. 16, pt. 3, p. 218.

The authors conducted a laboratory investigation on dogs to determine the effect of this new antimalarial remedy on the eyes. The experimental data show that in toxic doses the preparation, like other antimalarial agents, belongs to the category of neurotropic poisons, as it is absorbed by the nervous system. It is a poison to the ganglion cells of the retina, but it is less toxic than plasmocide, and appears to be safe in clinical doses.

Ray K. Daily.

Scholz, R. O. **A new detergent for use in the preoperative clean-up of the eyes.** Arch. of Ophth., 1940, v. 23, May, pp. 1060-1062.

Experiments on rabbits' eyes have shown that the sulfonated alcohol detergent now used at the Wilmer Ophthalmological Institute is better than soap commonly used because of its better detergent properties, neutrality, and lessened irritability. Clinical use has shown that the patients have less conjunctival irritation than when castile soap was employed. J. Hewitt Judd.

Tomai, Bruno. **The p_H of tears and aqueous humor after use of sulphanilamide.** Arch. di Ottal., 1939, v. 46, Sept.-Oct., p. 280.

Experiments were performed on humans and rabbits and the following conclusions drawn: (1) In a group affected with dacryocystitis in which sulphanilamide was injected intramuscularly, the p_H of tears showed a deviation toward the alkaline side. (2) In trachoma cases treated with sulphanilamide by mouth, there was also a change to the alkaline side. (3) In rabbits the change was not as great but there was definite shift to the alkaline side. (4) Little variation from normal was found of the p_H in the aqueous humor of rabbits after injection of sulphanilamide.

H. D. Scarney.

Venco, Luigi. **Experimental importance of chemotherapy of ocular pneumococcic infections by means of some organic derivatives of sulphur.** Arch. di Ottal., 1939, v. 46, Nov.-Dec., p. 307.

Pneumococci of types 1, 2, and 3

were introduced into the anterior chamber of rabbits, and by the use of sulphanilamide compounds a more effective protection against the organisms was obtained as compared to the control groups. There was little difference in the sensitivity of the three pneumococcic types, but sulfapyridine showed a bactericidal activity superior to parasulphanilamide. The effectiveness of sulphanilamide was found to be greater against the streptococci than the pneumococci. H. D. Scarney.

3

PHYSIOLOGIC OPTICS, REFRACTION, AND COLOR VISION

Banerjee, Haridas. **Presbyopia in India.** Proc. All-India Ophth. Soc., 1938, v. 6, pp. 165-166.

After an analysis of clinical observations on over 2,000 patients in the Eye Infirmary of Calcutta, the conclusion is reached that presbyopia in India starts at a much earlier age than in Europe. Banerjee gives the age incidence of presbyopia in Europeans as about 47 and that of Indians as about 37 years. Coincidentally, it is noted that in India hair becomes gray at an earlier age. Early presbyopia is ascribed to early lens sclerosis, tropical heat, and possibly a damaging influence of radiant energy upon the ciliary body. Lawrence G. Dunlap.

Bhau, T. N. **Incidence of refractive errors seen in Sir Ganga Ram Hospital.** Proc. All-India Ophth. Soc., 1938, v. 6, pp. 167-168.

A table of the local percentages of refractive errors.

Lawrence G. Dunlap.

Clark, Brant. **Binocular anomalies and reading ability.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 885-891.

Dashevsky, A. I. **Diagnosis and treatment of asthenopia.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 156.

The author aims at a differential diagnosis of accommodative and muscular asthenopia. The test for accommodative asthenopia is based on the concave lenses which accommodation can overcome. The state of convergence is measured by the amount of base-in prism which can be overcome and held for five minutes. Charting of the accommodation and convergence for a period of five minutes gives a graphic record of these functions. Treatment consists in orthoptic training of the ciliary muscles or internal recti, as the case indicates. Ray K. Daily.

Ferree, C. E., and Rand, G. **The projection method of presenting the test object for testing visual acuity.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 882-884.

Freiman, S. I. **Physiologic norms of depth perception for distance.** Viestnik Ophth., 1940, v. 16, pt. 4, p. 262.

The principal objective of this investigation was the evaluation of Litinski's device for depth perception and his proposed norms. The data verify his findings, establishing as normal the recognition of a depth difference of 10 to 20 mm. Normal visual acuity does not necessarily assure normal depth perception, but there appears to be a correlation between visual acuity above normal and superior depth perception. A similar correlation exists between interpupillary distance and depth perception. Litinski's device, which is accurate, portable, and convenient, is most suitable for the practical tests of depth perception. Ray K. Daily.

Friedman, Benjamin. **Comments on the teaching of refraction.** Arch. of Ophth., 1940, v. 23, June, pp. 1175-1180.

Many valuable impressions from the author's experience are presented in his discussion of cycloplegia and mydriasis, the ophthalmometer, astigmatic charts, cross cylinder, manifest and postcycloplegic examination, cyclodamia, red-green test, cylinder retinoscopy, streak retinoscopy and velonoscopy, and the curriculum for classes of instruction in refraction.

J. Hewitt Judd.

Kekcheev, K. X. **The effect of other sensory activities on the visual sense.** Viestnik Opht., 1940, v. 16, pt. 4, p. 246.

A review of the literature on the effect of auditory, olfactory, taste, tactile, and pain impulses on achromatic and chromatic vision. The author explains this effect by Orbel's theory that the irritability of receptors in the central nervous system is under the influence of the vegetative nervous system. The sympathetic and parasympathetic systems act as regulators, enabling the higher cerebral centers to adapt themselves functionally to the demands of the environment. This reaction of the higher cerebral center is phylogenetically a primitive reaction of the entire organism to its environment; it developed prior to the appearance of specialized receptors, the activities of which are tied up with sensations. The changes in the threshold of perception of chromatic and achromatic vision, in the electric sensitivity of the eye, and in blinking frequency under the influence of activity of other sense organs are thus regarded as vegetative reflexes. The author envisages the possibility of using these ocular functions as indicators of the effect of various physical and chemical agents on the entire organism. Ray K. Daily.

Kravkov, S. V. **The influence of odors upon color vision.** Acta Ophth., 1939, v. 17, pt. 4, p. 426.

The detailed data of this investigation show that olfactory stimuli may influence color vision in a normal trichromatic eye. The odors of bergamot oil, camphor, and geraniol heighten the sensitivity of the green-sensitive apparatus, and reduce the sensitivity of the red-sensitive apparatus. No effect was demonstrable in a deuteranopic eye. Ray K. Daily.

Luckiesh, M., and Moss, F. K. **New method of subjective refraction involving identical techniques in static and in dynamic tests.** Arch. of Ophth., 1940, v. 23, May, pp. 941-956.

The techniques and data presented in this article are based on the specific introduction of brightness-contrast as a criterion of visibility in certain phases of subjective refraction. This criterion is not only a fundamental one in physiologic optics but a unique one from the point of view of refraction, since it permits the functioning of convergence in the absence of a stimulus for relative accommodation. Brightness-contrast thresholds may be obtained by placing gradient filters directly in front of the eyes and altering the density of these filters until the test object located at some near point or at a distance is barely perceived. The visibility of the test object under these conditions is then read directly from a scale associated with the circular gradient filters, which are previously calibrated in terms of visibility. This process is repeated with trial lenses of various powers placed successively before the eyes. The results of the examinations using the authors' sensitometer under both dynamic and static condi-

tions are reported and compared. It is found that if all stimuli for accommodation are avoided while an adequate stimulus for convergence remains, the normal adult nonpresbyopic eye is myopic at distance and emmetropic at the near point. On the assumption that presbyopia is inescapable, the best imaginable compromise would give emmetropia at infinity during adolescence and emmetropia at arm's length in middle age, with distant vision still attainable by the exercise of negative relative accommodation. This condition is almost precisely the average condition found by the sensitometric method as it has been defined by the authors. J. Hewitt Judd.

McFarland, R. A., and Halperin, M. H. **The relation between foveal visual acuity and illumination under reduced oxygen tension.** Jour. Gen. Physiology, 1940, v. 23, May 20, p. 613.

The foveal visual acuity of 11 subjects was studied in relation to illumination under normal atmospheric conditions and at simulated altitudes of 10,000 and 18,000 feet. The reduced oxygen tensions resulted in a relatively large decrease in visual acuity at low illuminations but anoxia produced less and less change as the illumination increased until at very high illuminations the decrease in visual acuity was negligible. Edna M. Reynolds.

Maude, J. D. **Conical cornea with lenticular astigmatism.** Med. Jour. Australia, 1940, v. 1, March 16, p. 381.

The case of a male, aged 31 years, having conical cornea is reported. Final contact lenses with a power of −2.00 D. ground on the glass were tolerated for 8 to 12 hours but there was complaint of poor vision. Retinoscopy with the contact lenses in place revealed myopic astigmatism. The vision of the right eye was improved from 6/18 to 6/6 with a −2.25 cyl. ax. 180; that of the left from 6/12 to 6/6 with a −1.75 cyl. ax. 64. To overcome this lenticular astigmatism, the patient needed spectacles as well as contact lenses. Mention is made of the fact that the majority of cases of conical cornea are hyperopic. In this case the myopia was due to the presence of a superimposed moderate degree of keratoglobus.

F. M. Crage.

Metcalfe, E. E. **A new method for determining night blindness.** United States Naval Med. Bull., 1940, v. 38, April, p. 231.

A method for testing night blindness is presented, depending upon the length of time required for the eye to return to normal after exposure to illumination of sufficient intensity to impair vision temporarily. The advantages of the test are that it involves no pre-exposure in a dark room and that the size of the pupil, accommodation, and errors in refraction are not factors.

Edna M. Reynolds.

Ogle, K. N. **Induced size effect with the eyes in asymmetric convergence.** Arch. of Ophth., 1940, v. 23, May, pp. 1023-1038.

The author describes his apparatus and method of examination and presents data to show that no regular horizontal displacement in the induced-effect S curves occurs when the eyes are turned in asymmetric convergence, in spite of the geometric difference introduced in the relative sizes of the retinal images of the two eyes. These results give additional evidence to sup-

port the theory that a change in the relative functional sizes of the ocular images of the two eyes occurs in the vertical meridian when the eyes are turned in asymmetric convergence and that in general this change is of an amount which offsets the difference in the distance of the observed object from the two eyes. No direct evidence as to a compensation for the difference in the sizes of the images in the horizontal meridian is available from these experiments. J. Hewitt Judd.

Park, G. E., and Park, R. S. **Further evidence of change in position of the eyeball during fixation.** Arch. of Ophth., 1940, v. 23, June, pp. 1216-1230.

This report is based on the study of the relation of the excursions of aphakic and phakic eyes in reading similar material under similar conditions. An ophthalmograph was modified so that by using a second pair of lights and half-eye test lenses the light from the lamp reached the cornea above the reading lens and was reflected back toward the photographic cells uninfluenced by the lens. In this way the actual excursion of the eye was recorded, irrespective of the sign or power of the reading lens. In the aphakic eye the possibility of the lens and ciliary muscle influencing the position of the eye has been eliminated. In reading a line the aphakic eye has to compensate for the reading lens, thereby causing a greater excursion. The hyperopic eye, still maintaining its ciliary muscle and lens, is able to compensate for the reading lens so that the rectus muscles do not have to move the eye any further than an emmetropic eye. A myopic eye still is able to compensate for the reading lens, so that the rectus muscles do not have to move the eye as far as an emmetropic eye, thereby conserving much nervous and muscular energy as compared with the aphakic eye. J. Hewitt Judd.

Polack, A. **The spinning disc and pigmentary colors.** Bull. Soc. d'Opht. de Paris, 1938, Jan., p. 28.

This is a description of an apparatus by means of which various color combinations on discs are made to produce monochromatic effects by spinning the discs. George A. Filmer.

Thordarson, U. **Self-experimentation in artificially produced night blindness.** Acta Ophth., 1939, v. 17, pt. 4, p. 477.

The author reduced his vision with Tscherning's photometric glasses and studied the subjective difficulties caused by the reduced light. At night, in a light with which he could normally manage well, he was rendered helpless with a no. 2.00 glass, but with a no. 1.50 glass lens he could get about with difficulty; glasses below no. 1.00 density caused no interference. The author points out that a hemeralope encounters difficulties with illumination ten times as strong as that which causes symptoms in a normal person. Avitaminosis is to be suspected in patients who complain of poor vision in fairly good light, rather than in patients whose vision is poor on dark cloudy nights. Ray K. Daily.

Velhagen, K. **The question of normal color sense in street traffic.** Klin. M. f. Augenh., 1940, v. 104, April, p. 377.

Normal color sense gives the assurance that under all circumstances the colors of traffic signals are correctly recognized. But arrangements must be made which allow the safe recognition of the signals independently of their color. This can be done by always

placing red above, yellow in the middle, and green below in the signal lamps.

C. Zimmermann.

Weigert, F., and Morton, J. W. **Photochemical studies on color vision.** Ophthalmologica, 1940, v. 99, April, p. 145.

By impregnating gelatin films with visual purple which had been extracted from the retinae of frogs by means of digitalin, the authors made "artificial retinae." The maximum increase of transparency produced in such a film when exposed to light of a wave length which is photochemically effective may be recorded and expressed as a color graph. The determination of such a color graph is the first objective method for defining in physical language the hue of a colored light independent of a human observer. A "white" color graph exhibits its maximum at 530 mu. The composite nature of purple is shown by maxima in red and blue. If the artificial retina is exposed to red light, it becomes "blind" for red light but retains its sensitivity over the rest of the spectrum.

F. Herbert Haessler.

Wiener, M. **A surgical experiment in changing the refraction of the eye.** Proc. Soc. Exper. Biology and Med., 1940, v. 43, Feb., p. 384.

The eye of a dog may be lengthened by excising elliptical segments of sclera from four opposite sides of the eye and bringing the edges together by sutures. If the four excised ellipses are 9 mm. long and 1.5 mm. wide, the eye will be lengthened approximately 2.5 to 3 mm. The refraction is changed from about normal to 8 or 9 diopters minus. The eyeball may be shortened in a similar manner by removing segments in the quadrants between the recti. By this method the eye of a dog was shortened 1 mm., producing a refractive change of about 3 diopters. Experiments are being conducted on live rabbits.

John C. Long.

4

OCULAR MOVEMENTS

Bender, M. B., and Savitsky, N. **Paralysis of divergence.** Arch. of Ophth., 1940, v. 23, May, pp. 1046-1051.

The case of an 18-year-old girl is reported in which the initial and major symptom was paralysis of divergence, and in which at autopsy a single minute hemangioma was found in the periaqueductal central gray matter at the level between the superior and inferior colliculi. The clinical and pathologic data gathered from the study of this case lend considerable support to the theory that a center for divergence exists.

J. Hewitt Judd.

Berens, Conrad. **A prism bar of thermoplastic material for measuring high degrees of squint.** Amer. Jour. Ophth., 1940, v. 23, July, p. 805.

Dashevsky, A. I. **Diagnosis and treatment of asthenopia.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 156. (See Section 3, Physiologic optics, refraction, and color vision.)

Holm, Stig. **Concomitant strabismus in French equatorial Africa.** Acta Ophth., 1939, v. 17, pt. 4, p. 367.

The objective of this study was to determine whether there was a racial difference relative to the prevalence of strabismus. While on service in equatorial Africa the author examined the binocular balance of 1,931 persons, among whom he found 14 cases of strabismus, four of which were caused by traumatism or ocular pathology.

The incidence of strabismus was thus 0.52 percent, which is much lower than in the white race. The predominant type of strabismus in the black race is the alternating divergent, which was found in 11 cases. The author explains the rarity of convergent strabismus by the rarity of high degrees of hyperopia and astigmatism. The prevalence of alternating over monocular strabismus is attributed by the author to the predominance of isometropic refraction in the black race. Ray K. Daily.

Kaul, S. N. **Sixth-nerve paralysis of unknown origin.** Proc. All-India Ophth. Soc., 1938, v. 6, p. 161.

The patient, a Hindu aged 28 years, whose wife had died of tuberculosis four years previously, came with a paresis of the right external rectus muscle. The Wassermann and other tests were negative. He was hospitalized because of signs of gastric ulcer and a few hookworm ova in the stools. No improvement was noted in four months. Lawrence G. Dunlap.

Khautin, C. M. **The limits of heterophoria consistent with admission into aëronautic schools.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 148. (See Section 18, Hygiene, sociology, education, and history.)

Lavery, F. S. **Three cases of vertical strabismus cured by operation.** Trans. Ophth. Soc. United Kingdom, 1939, v. 59, pt. 2, p. 833.

The first patient was operated upon by recession of the inferior rectus, 20 degrees of vertical strabismus being corrected. The second and third patients had vertical as well as lateral strabismus. In the second patient operation on the lateral muscles had little effect, but in correction of the vertical strabismus by recession of the right inferior rectus the lateral deviation was also corrected. In the third patient correction of the lateral deviation also overcame the vertical deviation. Beulah Cushman.

Michail, D., and Rusu, L. **Myositis of the extraocular muscles.** Ann. d'Ocul., 1940, v. 177, March, pp. 97-117.

Primary extraocular myositis has been reported in the literature 11 times. The author adds two cases. The clinical picture consists of exophthalmos, often to the extent of corneal ulceration, and infiltration of the posterior portions of the extraocular muscles without marked limitation of movement or pain. The inferior oblique and inferior rectus are most frequently involved anteriorly enough to be palpated. The histologic picture is that of interstitial cellular involvement of the muscles with subsequent degeneration. The condition has been variously ascribed to syphilis, tuberculosis, other foci of infection, and unknown causes, but proof is commonly lacking. No mention is made of metabolic studies. Antisyphilitic treatment is of no avail and radiotherapy is little better. Secondary extraocular myositis may follow infections of the orbit or globe. Of the orbital infections, syphilitic periostitis is the most important, with tuberculosis, thrombophlebitis of the ophthalmic vein, foreign bodies, orbital cellulitis, and tenonitis as the other causes. The important ocular involvements are purulent panophthalmitis and chronically inflamed degenerating eyeballs.

John M. McLean.

O'Connor, Roderic. **Some interesting muscle cases with comments.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 904-906.

Ohm, J. **Familial occurrence of nystagmus in coal miners.** Graefe's Arch., 1940, v. 141, pt. 1, pp. 20-31.

After a discussion of the incidence and heredity of miner's nystagmus, the author presents the results of his experience with coal-mine workers over a period of thirty years. His observations on the maternal hereditary factors are incomplete. Heredity played a part in 12 percent of more than 2,400 patients with miner's nystagmus. He compares the members of the family as to the different nystagmus qualities. The occurrence of nystagmus seems to depend upon heredity and upon the conditions under which the patient works.

C. A. Perera and U. Ollendorff.

Yanes, T. R. **Paradoxic monocular ptosis.** Archives of Ophth., 1940, v. 23, June, pp. 1169-1172. (See Section 14, Eyelids and lacrimal apparatus.)

Young, J. **Amblyopia ex anopsia in children.** Brit. Jour. Ophth., 1940, v. 24, June, pp. 297-301.

The incidence of squint appears to be increasing. Most parents are not sufficiently informed as to the disabling qualities of squint, and school authorities do not recognize the importance of improving vision in the amblyopic eye as soon as possible. The average age for first examination of these cases is around eight years, whereas a much earlier diagnosis is necessary if satisfactory end results are to be obtained. Because of poor coöperation on the part of both children and parents, and to deal with difficult cases, the author has designed an occluder which he calls the "aëro-occluder." It is intended for permanent total occlusion for a period of six weeks or more. (Illustrated.) D. F. Harbridge.

5

CONJUNCTIVA

Alamilla, Gustavo. **Hypertrophy of the thymus in vernal conjunctivitis.** Arch. of Ophth., 1940, v. 23, June, pp. 1231-1242.

A six-year-old boy suffering from acute vernal conjunctivitis was found to be completely relieved after receiving a series of intense radiations for an extreme hypertrophy of the thymus gland. In four other cases an enlarged thymus was visualized radiographically, and all showed marked improvement after roentgen therapy. The author offers the hypothesis that hypertrophy of the thymus in children and persistence of the thymus in adolescents and adults is the cause or at least one of the factors in the production of vernal conjunctivitis. The paper includes the description of the technique for visualization of the thymus and the specifications for irradiation in adults and in children. (Discussion.)

J. Hewitt Judd.

Alexandrov, V. V. **Molluscum contagiosum.** Viestnik Opht., 1940, v. 16, pt. 4, p. 234.

A review of the literature and a report of three cases. In two of these the affection caused a stubborn conjunctivitis. Ray K. Daily.

Ayberk, N. F. **Three cases of unilateral trachoma.** Rev. Internat. du Trachome, 1939, Oct., v. 16, p. 192.

Three case reports are given.

Bengtson, I. A. **The question of the rickettsial nature of trachoma.** Amer. Jour. Ophth., 1940, v. 23, July, pp. 770-779.

Cecchetto, Ezio. **The sulphamides in the treatment of gonorrheal conjunc-**

tivitis. Rassegna Ital. d'Ottal., 1940, v. 9, Jan.-Feb., p. 97.

Cecchetto has used Tioseptal in the treatment of gonorrheal conjunctivitis and in septic wounds of the eye, with very satisfactory results. Tioseptal is a sulphamide with one pyridine group introduced into the molecule. Seven cases are briefly reported.

Eugene M. Blake.

Cornet, Emanuel. **The giant follicle of Meyerhof.** Ann. d'Ocul., 1940, v. 177, March, pp. 131-133.

This lesion consists of confluent "sago-grain" trachomatous follicles at the limbus. Formerly Cornet treated them by curettage or injections of mercury cyanide. Now he excises them with scissors. John M. McLean.

Cosgrove, K. W. **The local use of sulphanilamide in trachoma.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 911-913.

Curtis, W., Curtis, H. O., and Sanders, M. **Chronic conjunctivitis due to the virus of venereal lymphogranuloma.** Jour. Amer. Med. Assoc., 1940, v. 115, Aug. 10, p. 445.

The author reports a third case of chronic unilateral conjunctivitis of seven years duration due to the virus of venereal lymphogranuloma. Sulphanilamide checked the active process and reduced the accompanying edema and stasis. The vision of the eye had been destroyed years before. The virus was determined by tissue culture, which apparently is a more delicate means than animal inoculation. (4 figures, tables, bibliography.) George H. Stine.

Derkac, V. **The significance of the Weil-Félix reaction in trachoma.** Graefe's Arch., 1940, v. 141, pt. 1, pp. 117-124.

The author reviews the findings of previous workers and reports the results of his examination of the blood of 300 patients, 213 of whom had trachoma. Of the remaining 87 patients, 20 were suffering from ocular disease other than trachoma, and 67 were lice-infested schoolchildren. The Weil-Félix reaction was positive in 39 percent of the patients with chronic trachoma, and in a much higher percentage of those with bilateral pannus. The lice-infested children gave a positive reaction in 45 percent of the cases; the reaction was negative in the remaining nontrachomatous patients.

Charles A. Perera.

Eroshevskii, T. I. **Partial transplantation of preserved cadaver tissue in some ocular diseases.** Viestnik Opht., 1939, v. 15, pt. 6, p. 23. (See Section 6, Cornea and sclera.)

Foroni, Camillo. **The treatment of headaches with "oftalmo-massoressi."** Graefe's Arch., 1940, v. 141, pt. 1, pp. 32-45.

Certain "idiopathic" stubborn headaches are often associated with chronic conjunctivitis, which is frequently unrecognized. The author believes these headaches to be due to toxins which affect the meninges or their vessels. He has treated conjunctivitis for 25 years with a method to which he gives the name "massoressi." It consists in massaging the bulbar and palpebral conjunctiva with a special spatula, so that hemorrhages are produced. These hemorrhages are essential for the success of the method.

Charles A. Perera.

Katznelson, A. B. **Lichenoid tuberculoids of the conjunctiva.** Viestnik Opht., 1939, v. 15, pt. 6, p. 32.

Six cases are reported. Tuberculoid

diseases of the conjunctiva occupy clinically, morphologically, and pathogenetically an intermediate position between the classical tuberculous process and allergic tuberculous phlyctenular disease. (Photomicrographs.)

Ray K. Daily.

La Rocca, Vito. **Treatment of vernal catarrh with solid carbon dioxide.** Arch. of Ophth., 1940, v. 23, May, pp. 1039-1045.

Ten patients with vernal catarrh were treated at weekly intervals with applications of solid carbon dioxide in a metallic container. In nine cases the catarrh was of the tarsal type and in one of the limbic type. Generally, all persons responded favorably to this kind of therapy. In two cases in which the results were not wholly successful, the number of treatments was insufficient. The patient with the limbic type responded quickly to this treatment, being cured after six treatments. Some of the patients considered cured were followed for more than four years without relapses being observed.

J. Hewitt Judd.

Lee, O. S., and Rottenstein, H. **Trachoma treated with sulphanilamide and its derivatives.** Jour. Amer. Med. Assoc., 1940, v. 115, July 13, p. 107.

The authors treated 75 patients with trachoma with sulphanilamide by the oral route and twenty patients by intramuscular injections. The treatment was definitely effective against trachoma in stages I, II, and III. Intramuscular administration of the drug was preferred. In the oral administration the daily dose was 0.02 gm. per pound of body weight and the duration of the treatment varied from two to four weeks. In the intramuscular administration the dose was from 2 to 5 gm. per injection, sulphanilamide being given every four days and sulfapyridine every seven to ten days. From two to six injections were all that were necessary, no further improvement having been observed with more prolonged treatment. (2 tables, one figure, case reports, bibliography.)

George H. Stine.

Lindner, K. **The general pathology of infectious conjunctivitis.** Trans. Ophth. Soc. United Kingdom, 1939, v. 59, pt. 2, p. 838.

Pneumococci, Koch-Weeks bacilli, gonococci, and diplobacilli have been found to grow on the living epithelial cells of the cornea and to produce infectious conjunctivitis. They have all been found to fulfill the postulates of Koch. Staphylococcus aureus grows only on dead epithelial cells, and may sometimes cause angular but not purulent conjunctivitis.

Beulah Cushman.

Löwegren, Agne. **Case of agranulocytosis with ocular lesion.** Acta Ophth., 1939, v. 17, pt. 4, p. 412. (See Section 6, Cornea and sclera.)

MacCallan, A. F. **Sulphonamide treatment of bacterial and trachomatous conjunctivitis.** Rev. Internat. du Trachome, 1939, Oct., v. 16, p. 197.

After reviewing the literature as to the action of the sulphonamide group of drugs the author recites his own experiences. He is of the opinion that the benefit derived is due to elimination of the superimposed bacterial infection.

J. Wesley McKinney.

Nagy, Ferenc. **Trachoma and the Weil-Félix reaction.** Orvosi Hetilap, 1940, v. 84, April, p. 205.

To test Derkač's statement that the blood serum of patients with trachoma

gives in a high percentage of cases a positive Weil-Félix reaction (see Amer. Jour. Ophth., 1939, v. 22, p. 215), the author repeated the test using the serum of 100 patients with severe trachoma, and the serum of normal patients as controls. Although the trachoma serum gave a positive reaction in a higher number of cases than the normal serum, the difference was so minimal that no value can be attributed to the Weil-Félix reaction, in regard either to diagnosis or to etiology.

R. Grunfeld.

Nicolato, A. **Reconstruction of the conjunctival sac in anophthalmos.** Rassegna Ital. d' Ottal., 1940, v. 9, Jan.-Feb., p. 41.

This is a general discussion of the problems which face ophthalmic surgeons in the reconstruction of the conjunctival sac after traumatism. The author discusses various procedures and experiences. (13 figures.)

Eugene M. Blake.

Reis, Karolina. **The serologic reaction of Weil-Félix and trachoma.** Rev. Internat. du Trachome, 1939, v. 16, Oct., p. 181.

Persons affected by a number of types of ophthalmia, as well as trachoma, were subjected to the Weil-Félix serologic test. The conclusion as to trachoma was that no diagnostic significance could be attributed to this reaction. J. Wesley McKinney.

Sugita, Y. **The nature of Prowazek's bodies and the other inclusion bodies, in the light of artificial production of such bodies by our physico-chemical method.** Graefe's Arch., 1940, v. 141, pt. 1, pp. 46-58.

The author was successful in producing inclusion bodies in the epithelial cells of human conjunctiva and of rabbit epidermis. He made use of the micromanipulator, and describes his method of injecting chromium sulphate into the cytoplasm of a single cell. The result was the formation of an inclusion body which was identical with Prowazek's body when stained with Loeffler's and Giemsa's reagents. The intracellular structure thus produced consisted of coagulated protoplasmic albumen. The author discusses the physico-chemical basis for his experiments, the similarity of his artificially produced bodies to Prowazek bodies, the development of the inclusion bodies in virus infection, and the staining properties of the artificial and virus-produced bodies. He believes that the inclusion bodies of Prowazek must consist of coagulated granules and masses of protoplasmic albumen.

Charles A. Perera.

Sysi, R. **Treatment of gonorrheal conjunctivitis with "M and B 693."** Acta Ophth., 1939, v. 17, pt. 4, p. 466.

This preparation (2-sulfanilyl-aminopyridine) was used in 11 cases of gonorrheal ophthalmia with excellent results. No milk injections were used. Five cases were treated locally with silver nitrate and argyrol, and the others with saline irrigations. In some cases the drug affected the kidneys, but it is hoped that this effect will be eliminated with the determination of exact dosage. Ray K. Daily.

Szinegh, Béla. **Contributions to the chemotherapy of trachoma.** Graefe's Arch., 1940, v. 141, pt. 1, pp. 109-116.

The author briefly discusses the literature concerning the chemotherapy of trachoma, with particular attention to "deseptyl" (p-aminobenzolsulfamide) and "elektyl" (4/4′-aminoben-

zolsulfamido - benzolsulfonidmethylamide). He reports his experiences with 18 patients treated with "deseptyl," and 35 with "elektyl." The former drug lessens the symptoms and shortens the treatment period of trachoma but does not cure it. "Elektyl" is more effective, but only in cases with pannus. These agents may act by influencing the secondary infection in cases of trachoma. Sulphamides gave no results in the treatment of adults suffering from inclusion conjunctivitis. The author compares gonorrhea and trachoma from a geographical and historical viewpoint, and discusses the effects of treatment with the sulphamides.

Charles A. Perera.

Talkovskii, S. I. **Primary tuberculosis and lupus of the conjunctiva.** Viestnik Opht., 1940, v. 16, pt. 4, p. 212.

A report of two cases of lupus of the conjunctiva in conjunction with lupus of the face. The differential diagnosis between primary tuberculosis and lupus is made on the morphology of the conjunctival lesion, the absence of adenopathy, the bilateral involvement, and the age of the patient. The tubercle bacillus is the etiologic agent in both affections. The author regards primary tuberculosis as a hematogenous disease, and lupus as of an exogenous nature secondary to lupus in adjacent areas. Ray K. Daily.

Terrien, F., and Halbron, P. **A case of corneo-conjunctival xerosis.** Bull. Soc. d'Opht. de Paris, 1938, May, p. 185. (See Section 6, Cornea and sclera.)

6

CORNEA AND SCLERA

Cogan, D. G. **Experimental production of so-called bullous keratitis.** Arch. of Ophth., 1940, v. 23, May, pp. 918-925.

This is a preliminary report of the experiments in which whole enucleated animal eyes were immersed in hypertonic solutions and in which hypertonic solutions were injected into the anterior chamber to produce an artificial relative hypertonicity of the cornea. The eyes were then immersed in hypotonic solutions. It was found that a vesiculation of the cornea similar to bullous keratitis could be produced, apparently by absorption of fluid from the outside inward when the osmotic tension of the cornea was greater than of fluid on the outside of the eye. This vesiculation is reversible, as the vesicles and bullae will disappear when the eye is again placed in a hypertonic solution. The role of the endothelium is not certain, and it is necessary to assume a differential permeability of the epithelium and Bowman's membrane in order to explain the subepithelial position of the vesicles.

J. Hewitt Judd.

Eisenberg-Merling, K. B. **Observations on living vaccinia virus in the corneal cells of the rabbit.** Jour. Path. and Bact., 1940, v. 50, March, p. 259.

The observations deal mainly with the direct examination, under dark illumination, of the development of the unstained vaccinia virus in the living corneal cells of the rabbit. It is assumed that the inclusion bodies in the living cells represent the Guarnieri bodies of fixed and stained preparations. The author links the observed changes of the living virus not only with the Guarnieri bodies but with similar observations on the life cycle of the pleuropneumonia virus.

F. M. Crage.

Eroshevskii, T. I. **Partial transplantation of preserved cadaver tissue in some ocular diseases.** Viestnik Opht., 1939, v. 15, pt. 6, p. 23.

This method of clearing corneal opacities and arresting inflammatory phenomena is based on clinical observation made by Filatov. At the author's hands the best results were obtained in corneal opacities of malarial etiology. In opacities of parenchymatous and scrofulous keratitis the procedure was followed by marked improvement. The preservation period should be limited to 6 or 7 days for the cornea and 2 or 3 days for the conjunctiva.

Ray K. Daily.

Grawitz, P. B. **When is a cornea dead?** Graefe's Arch., 1940, v. 141, pt. 1, pp. 59-71.

The author has studied the effects of dry and moist heat, and of chemical protoplasmic poisons upon segments of rabbit corneas. Following the experimental injury, the corneal segments were implanted within the abdominal cavities of rabbits and examined microscopically after 48 hours incubation. Some of the corneal tissue was studied in tissue culture. According to his findings, the author reports that corneal tissue is highly resistant to drying, heat, and chemical agents, requiring temperature above 170°C. for complete tissue death. Immigration of leucocytes does not take place in implanted corneal tissue, whether dead, injured, or normal. The connective-tissue elements have polyblastic tendencies and react with chromatin proliferation, normally with round-cell formation. Tissue implantation is excellent for the study of damaged tissues as well as for cancer investigation.

Charles A. Perera.

Haldimann, C. **Sympathetic ophthalmia and keratitis herpetica.** Ophthalmologica, 1940, v. 99, April, p. 187. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

Johnson, L. V., and Eckardt, R. E. **Rosacea keratitis and conditions with vascularization of cornea treated with riboflavin.** Arch. of Ophth, 1940, v. 23, May, pp. 899-907.

Of 36 patients with clinical rosacea keratitis, given orally at least 3 mg. of riboflavin daily, the four who did not respond satisfactorily showed altered gastric secretions, especially the amount of free hydrochloric acid. Thirty-two of the patients had prompt healing of the corneal lesions, and no recurrences during therapy with riboflavin. The similarity between the conditions of the eyes with rosacea keratitis and the conditions of eyes of rats in which ulcers developed because of deficiency of riboflavin in the diet is pointed out. The mechanism is thought to be inadequate oxidation of the enzymes, such as Warburg's yellow enzyme, in the avascular cornea. The authors feel that rosacea keratitis may be the direct result of riboflavin deficiency, and the formation of new blood vessels, telangiectasia, corneal vascularization, and distension of vessels may possibly be part of the physiologic response of blood vessels to deficient oxidative reactions. Riboflavin therapy apparently is of no value in conditions accompanied by large blood vessels or in injuries in which scar tissue is present. For constant benefit continuous therapy is advisable. (4 natural color photographs.) J. Hewitt Judd.

Kaul, S. N. **Hydrothermal treatment of corneal ulcers.** Proc. All-India Ophth. Soc., 1938, v. 6, pp. 95-97.

The author mentions the many cautery measures common in the treatment of corneal ulcers (tincture of iodine, phenol, thermocautery, electrocautery, metric cautery), and also paracentesis and Saemisch section. The etiologic factor of corneal ulcer is thoroughly considered. Kaul describes a cheap and easy method of treatment, which he calls the hydrothermal treatment. This consists in dropping boiling water directly on to the ulcerated area. The treatment is contraindicated in descemetocele where paracentesis is preferable, or in the presence of hypopyon. Following the treatment a pad and bandage are applied to the affected eye until the ulcer is healed. A report on the microörganisms found in 106 cases of corneal ulcer is also given.

Lawrence G. Dunlap.

Löwegren, Agne. **Case of agranulocytosis with ocular lesion.** Acta Ophth., 1939, v. 17, pt. 4, p. 412.

Reference is made to the four cases reported in the literature. The author's patient, a woman 66 years old, became seriously ill with fever, angina, and pain in the left eye caused by a necrotic process of the cornea and conjunctiva. The diagnosis was made from the blood picture. The patient recovered after institution of treatment, but the eye was lost. (Illustration.)

Ray K. Daily.

Maude, J. D. **Conical cornea with lenticular astigmatism.** Med. Jour. Australia, 1940, v. 1, March 16, p. 381. (See Section 3, Physiologic optics, refraction and color vision.)

Müller, H. W. **Treatment of serpent ulcer of the cornea with detoxin.** Klin. M. f. Augenh., 1940, v. 104, April, p. 438.

Four cases are reported in detail with strikingly good results after treatment with detoxin. The most serious case required 26 days of treatment; another required 18 days, and two 14 days.

C. Zimmermann.

Stokes, W. H. **Ocular manifestations in hydroa vacciniforme.** Arch. of Ophth., 1940, v. 23, June, pp. 1131-1145. (See Section 17, Systemic diseases and parasites.)

Strachov, V. P. **An analysis of the second series of keratoplasties.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 99.

Detailed reports of sixteen cases, operated upon from 1934 to 1939. Strachov concludes that the technique is simple enough for widespread application but the visual improvement following corneal grafting is only moderate. The operation does not add to the visual ability of a person with one good eye, but for patients without useful vision in either eye an improvement of 0.1 in visual acuity is of great significance. Ray K. Daily.

Sydenstricker, V. P., Sebrell, W. H., Cleckley, H. M. and Kruse, H. D. **The ocular manifestations of ariboflavinosis.** Jour. Amer. Med. Assoc., 1940, v. 114, June 22, p. 2437.

Forty-seven patients with ocular symptoms of photophobia, dimness of vision, congestion of the sclera, vascularization and opacification of the cornea, and abnormal pigmentation of the iris, responded promptly and completely to riboflavin. The earliest lesion of ariboflavinosis was found to be proliferation and engorgement of the limbic plexus which progressed to superficial vascularization of the cornea and production of interstitial keratitis. (10 figures, several case reports, tables, bibliography.) George H. Stine.

Terrien, F., and Halbron, P. **A case of corneo-conjunctival xerosis.** Bull. Soc. d'Opht. de Paris, 1938, May, p. 185.

A severe case of xerosis in a young woman improved under treatment with vitamin A and tuberculin. The underlying cause of the xerosis was not ascertained. George A. Filmer.

Valerio, Mario. **Two rare forms of juvenile degeneration of the cornea.** Boll. d'Ocul., 1939, v. 18, Aug., pp. 659-670.

A man of 25 years showed a bilateral central yellowish-gray disciform opacity of the cornea surrounded by a 4-mm. ring of clear cornea. At the slitlamp the elements of the dystrophy appeared to form a mosaic located in Bowman's membrane. The vision was 5/10 in each eye. Another man of 25 years showed a 4-mm. disciform opacity in the center of each cornea. The opacity was composed of small spots which at the slitlamp appeared to be needle-shaped crystals. This mass was situated in the anterior two thirds of the corneal parenchyma. The vision was 6/10 in each eye. (Bibliography, 5 figures.) M. Lombardo.

Wiener, M., and Alvis, B. Y. **Transplantation of cornea by means of a mechanically obtained beveled-edge segment.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 877-881; also Trans. Amer. Acad. Ophth. and Otolaryng., 1939, 44th mtg., p. 124.

7

UVEAL TRACT, SYMPATHETIC DISEASE, AND AQUEOUS HUMOR

Ackerman, P. L. **Pupillary membrane.** Viestnik Opht., 1939, v. 15, pt. 6, p. 91.

Description of the biomicroscopic picture, seen in two cases, of an inflammatory membrane filling the pupil but not attached to the lens capsule. What factors prevent the attachment of the pupillary membrane to the lens capsule is as yet not understood. The possibility of extraction of the membrane without the lens is open to consideration. Ray K. Daily.

Boros, Béla. **The heredity of the heterochromic iris.** Orvosképzés, 1940, v. 30, Jan., p. 155.

The author describes a male patient who showed a white segment 5 mm. in diameter, in the brown iris of each eye. The pigment was absent only in the anterior stroma layer and not in the posterior retinal layer. The iris, therefore, could not be transilluminated. No signs of inflammation or of sympathetic disturbance could be noted. The heredity was apparently of recessive character, since the same iris anomaly was found in the eyes of an aunt and an uncle on his father's side, and the grandfather was said to have had similar irides. R. Grunfeld.

Brooks, W. D. W., Juler, F. A., and Williams, E. R. **On the relationship between chronic iridocyclitis and tuberculosis, and the appropriate therapy.** Brit. Jour. Ophth., 1940, v. 24, July, pp. 317-366.

Forty cases of chronic iridocyclitis were observed, the clinical history, physical examination, radiologic examinations of the chest, Wassermann and Mantoux reactions being obtained in each instance. The general condition of the cases is first presented, listing age, sex, age of onset, occupation, and social position. A report of radiologic observations, ocular conditions, laboratory investigations, biologic tests, biopsy, focal sepsis, treatment, and re-

sults of treatment precede the discussion. (Appendix of cases, figures.)

D. F. Harbridge.

Brown, E. V. L. **Retroretinal tissue from the choroid in Kuhnt-Junius degeneration of the macula.** Arch. of Ophth., 1940, v. 23, June, pp. 1157-1168.

An anatomic study of a case of disciform degeneration of the macula in a 74-year-old woman is presented. Long stretches of vascularized preequatorial tissue were found between Bruch's membrane and the pigment epithelium without demonstrable breaks in the membrane. There also was a large mass of new tissue in the macular region. Anterior to and continuous with this, and temporal to the fovea, was a mound or several mounds merged into one. The outer layers of the retina were destroyed in front of the mound and fused to it by glia. The fore part of the basal lesion consisted of pigment epithelium proliferated into a "connective" tissue. The back portion (next to the choroid), which was genuine richly vascularized connective tissue, continued directly into the tissue of the mound, which was old and full of collapsed, obliterated, newly formed vessels but free from pigment. A tiny vesicle lay beneath the raised pigment epithelial layer just temporal to the mound. It was full of proliferating unpigmented pigment epithelium and had a connection with the choroid through a small break in the lamina vitrea near the mound. There were numerous other breaks through which blood, fibroblasts, capillaries, and larger vessels made their way from the choroid into the basal tissue and mound. Hemorrhage was abundant. The author holds that definite breaks in the lamina basalis are not necessary for the formation of extensive retroretinal tissue. Changed secretions or simply a marked increase in normal secretion from the choroid and its accumulation into a bleb or vesicle of stagnant albuminous fluid beneath the pigment epithelium would be sufficient to excite marked proliferation of the pigment epithelium.

J. Hewitt Judd.

Casini, Francesco. **Xanthomatosis bulbi with ossification of the choroid.** Arch. di Ottal., 1939, v. 46, Nov.-Dec., p. 333. (See Section 13, Eyeball and orbit.)

Dieffenbach, Pierre. **Heerfordt's syndrome with Besnier-Boeck disease.** Bull. Soc. d'Opht. de Paris, 1938, May, p. 294.

The author reports a case of uveoparotid fever (Heerfordt's syndrome) in a 30-year-old man who was subsequently found to have sarcoidosis. It is noted that uveoparotid fever may be one manifestation of the general condition.

George A. Filmer.

Duggan, W. F. **Acute exudative choroiditis. Pathologic physiology; treatment with vasodilators.** Arch. of Ophth., 1940, v. 23, May, pp. 930-940.

After reviewing the general characteristics of acute exudative choroiditis and pointing out that the juxtapapillary type differs from the usual type only because of its location adjacent to the optic disc, the author reports five cases in which vasodilator therapy only was used. In four there was marked and prompt improvement of vision, while in the fifth the choroidal and retinal pathologic process was found to be so severe and the vascular supply so impaired that the therapy did not materially improve the condition. The author points out that acute choroiditis, acute retrobulbar neuritis, and acute spastic closure of the central

retinal artery or one of its branches all have in common an acute localized arteriolar spasm, resulting in capillary dilatation, increased capillary permeability, transudation of plasma and cells, and anoxia of the tissues. Vasodilator therapy directed toward relieving this arteriolar spasm has a sound physiologic and pathologic basis.

J. Hewitt Judd.

Franceschetti, A., and Valero, M. **Recurrent uveitis with hypopyon—a mucocutaneous ocular syndrome.** Rassegna Ital. d'Ottal., 1940, v. 9, Jan.-Feb., p. 1.

The unusual condition of an iridocyclitis with dense hypopyon recurring monthly was first described by Quaglino in 1871. Various authors have considered different causes (staphylococcus toxemia, tuberculosis, allergy). The disease affects more especially males between the ages of twenty and forty years, the attacks appearing rather abruptly and leading to rapid loss of sight. The anterior chamber is some times half filled with exudate, and the vitreous becomes cloudy. The hypopyon clears quickly, the vitreous more slowly. One or both eyes may be affected. The writers are convinced that the ocular symptoms are part of a general syndrome in which aphthous patches occur in the mouth and genitals, and occasionally erythema nodosum is present. Four cases carefully studied seem to bear out this impression. Two of the patients regained good vision and two became practically blind. No specific treatment has been found. (3 figures.)

Eugene M. Blake.

Haldimann, C. **Sympathetic ophthalmia and keratitis herpetica.** Ophthalmologica, 1940, v. 99, April, p. 187.

The author describes two cases of sympathetic ophthalmia associated with a herpetic lesion. The first patient had a severe herpetic keratitis after nonperforating trauma. One year later a smouldering uveitis with optic neuritis developed in the second eye. The first eye, practically blind, was enucleated. In serial section, no evidence of perforation could be found, but there was the characteristic histologic picture of sympathizing uveitis. The second eye healed in the course of several months. In the second patient, who had had recurring attacks of keratitis disciformis, the second eye suddenly developed a central deep keratitis and optic neuritis. Under treatment the eye healed. Of course no histologic confirmation of the author's opinion that the affection of the second eye was endogenous and sympathetic is available.

F. Herbert Haessler.

Jensen, J. P. **Some cases of sympathetic ophthalmia.** Acta Ophth., 1939, v. 17, pt. 4, p. 388.

Among 307 perforating ocular injuries treated at the Community Hospital in Copenhagen during the years 1927 to 1936, there were five cases of sympathetic ophthalmia. These are reported in detail. One was of a child in whom both eyes were saved with good vision. Four were of adults in each of whom the injured eye was removed; a considerable time after the injury an iridocyclitis appeared in each of the remaining eyes. Two cases recovered with 6/6 vision; two others were complicated by secondary glaucoma with total loss of vision.

Two cases of sympathetic ophthalmia are reported from the National Hospital, Copenhagen. The first patient developed a mild serous cyclitis in the injured eye and ten months later

papilloretinitis and retinochoroidal changes of drusen-like character in the other eye. In the second patient, the ruptured eyeball was enucleated 14 days after the injury; 26 days afterward the remaining eye developed an optic neuritis and a serous choroiditis with large vitreous opacities.

Ray K. Daily.

Romanova-Bokhon, O. A. **Pupillary reactions after sympathetic denervation.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 108.

This laboratory investigation on rabbits deals with the response of the pupil to instillation of adrenalin and cocaine after extirpation of the cervical sympathetic. The data indicate that adrenalin instilled into the conjunctival sac does not act on the pupil through the sympathetic fibers, because adrenalin continues to act on the iris after extirpation of the cervical sympathetic. It probably acts on the iris through the myoneural sheath or through the contractible tissue of the muscle fibers. The mydriasis following instillation of cocaine is lost several days after section of the cervical sympathetic. This indicates that cocaine acts on the terminal sympathetic endings in the iris, and after their degeneration the pupil ceases to respond. Ray K. Daily.

Stromburg, G. **End results of tuberculous uveitis.** Klin. M. f. Augenh., 1940, v. 104, April, p. 384.

A survey of five hundred cases of tuberculous uveitis treated at the eye clinic of Freiburg from 1900 to 1930 shows that the ultimate prognosis of insidious intraocular tuberculosis proved to be very bad when the patients were followed over a long period.

C. Zimmermann.

Tichomirova, H. **Adaptation studies on patients with tuberculous choroiditis.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 121.

The author maintains that dark adaptation is very sensitive to retinal edema. The adaptation curve taken during the period of focal reaction following tuberculin administration invariably shows a lowering and retardation of adaptation corresponding to the extent of retinal edema. The possibility of detecting fine variation in retinal edema makes the test valuable in studying the course of tuberculous choroiditis. Ray K. Daily.

Wegener-Thomsen, S. **Bone metaplasia in the eye.** Acta Ophth., 1939, v. 17, pt. 4, p. 482.

Review of the literature and report of a very unusual case. A woman 38 years old with a central choroiditis in the right eye had the left eye enucleated because it was hard, blind, and painful. This eye had in its upper nasal quadrant, midway between the equator and the limbus, a round, smooth, hard protuberance with a diameter of 5 mm., and a height of 2 mm. Microscopic section revealed a spongy ossification of the choroid in the form of a shell, partly absent near the iris and the disc. Microscopic section did not reveal the origin of the bone. The absence of evidence of former inflammation or neoplasm ruled out the diagnosis of inflammatory or neoplastic metaplasia. A possible diagnosis is embryologic metaplasia in a congenitally aphakic eye, or an injury in early childhood with rupture of the lens and choroid and subsequent ossification of the choriocapillaris. (Illustration.)

Ray K. Daily.

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GLAUCOMA AND OCULAR TENSION

Bhaduri, B. N., and Biswas, C. K. **Halos in epidemic-dropsy glaucoma.** Proc. All-India Ophth. Soc., 1938, v. 6, pp. 106-113.

In studying a large series of cases of epidemic-dropsy glaucoma, the authors found rainbow halos around lights as the earliest indication of the increase in tension and almost a constant symptom. In many cases the halos persist for years after complete disappearance of other signs of increased intraocular tension, or of general evidence of the disease elsewhere in the body. Theories as to the cause of halos are carefully considered.

Lawrence G. Dunlap.

Blake, E. M., and Leonard, J. C. **Blood differential count in chronic glaucoma.** Amer. Jour. Ophth., 1940, v. 23, Aug., pp. 907-910.

Bothman, Louis. **Glaucoma following irradiation.** Arch. of Ophth., 1940, v. 23, June, pp. 1198-1212; also Trans. Amer. Acad. Ophth. and Otolaryng., 1939, 44th mtg., p. 109.

The study is based on three cases, two of which are reported briefly and the third in detail. The outstanding pathologic change was the breaking up of anterior uveal pigment epithelium and its dispersion over the anterior surface of the iris and in the spaces of Fontana, with little vascular change and no synechiae. It is assumed that the pigment disturbance was due to the roentgen rays and that glaucoma resulted from a mechanical blocking of the flow of aqueous from the eye. Why irradiation produces cataract without glaucoma in some eyes, glaucoma without lenticular changes in others, or both conditions in still others is not known. The author points out that it is possible that there is a selective action of the rays for certain structures, but such selectivity has neither been explained nor can it be predicted. The changes are shown by photomicrographs. (Discussion.)

J. Hewitt Judd.

Curdy, R. J. **Subconjunctival Lagrange sclerectomy ab externo.** Arch. of Ophth., 1940, v. 23, June, pp. 1173-1174.

When the anterior chamber is shallow, the Lagrange linear fistula can be obtained by the external approach without the difficulties and dangers attending the usual technique. The author's method consists of preparation of a conjunctival flap 8 mm. wide similar to that used in the Elliot trephining operation, except that a longer arc of the limbus is exposed and the cornea is not split. An incision is made along the curve of the limbus, about 6 mm. long, perpendicular to the scleral surface, and close to the attachment of the conjunctiva at the limbus. Above this a second, more curved incision in the sclera is made inclined toward the first so that its middle is 1 mm. or a little more from the middle of the first incision but its two ends joining those of the first incision forming a scleral crescent. The incisions should not perforate at first, but should be deepened slowly by successive light strokes. If perforation occurs before the scleral crescent is entirely free, and iris prolapse occurs, iridectomy can be performed first and the scleral crescent dissected out afterwards. The internal opening of the fistula being smaller than the surface opening, the aqueous escapes with diminishing pressure into a large subconjunctival area. To facilitate making the scleral incisions,

a special knife has been devised with a blade 6 mm. long and 2 mm. wide, placed at an angle of 45 degrees from the line of the shaft.

J. Hewitt Judd.

Dejean, C., Guignot, R., and Artières, P. **Effects on ocular tension following retrobulbar injections of scurocaine with adrenalin.** Bull. Soc. d'Opht. de Paris, 1938, May, p. 198.

These injections were done on patients about to have intracapsular cataract extractions; reduction in tension was desired especially in those where loss of vitreous was feared. In 80 percent of the cases there was diminution in tension, reaching the maximum effect in from five to ten minutes. In 10 percent there was no change in the tension, while an elevation was noted in the remaining 10 percent.

George A. Filmer.

Dutt, S. C. **Bengal glaucoma; its treatment.** Proc. All-India Ophth. Soc., 1938, v. 6, pp. 114-121.

Dutt has seen many cases of Bengal or epidemic-dropsy glaucoma, and the incidence in thirty years has risen from 2 to 30 percent. It is characterized by uncommonly high intraocular tension, absence of pain or congestion, frequent absence of cupping, persistent transient halos in nearly all cases, and despite the high intraocular tension, often no loss of field. Binocular involvement is the rule with a normal pupil reacting well to light and accommodation until marked optic atrophy supervenes, the anterior chamber remaining deep. The treatment of the glaucomatous condition is the treatment of the epidemic dropsy itself. Pilocarpine (0.5 percent) gives better results than eserine, and massaging of the eyeballs is of distinct benefit. Medical treatment consists of ephedrine to the point of twitching and flagellation. Laxatives and diuretics and change of climate are urged. Fistulization by scleral trephining is advised, other classical glaucoma operations having been discarded.

Lawrence G. Dunlap.

Goldfeder, A. E., and Bushmich, D. G. **Nevus flammeus and glaucoma.** Viestnik Opht., 1940, v. 16, pts. 2-3, p. 114.

A report of two cases. In one an attack of acute glaucoma was provoked by instillation of atropine. The second was a case of simple glaucoma controlled by miotics. The author urges that, as a prophylactic procedure, persons with nevus flammeus be kept under ophthalmologic observation, and that dermatologists be made aware of the potential ocular complications.

Ray K. Daily.

Gradle, H. S. **Tension tolerance.** Jour. Amer. Med. Assoc., 1940, v. 115, Aug. 17, p. 495.

The author introduces a new term, "tension tolerance" as more comprehensive in meaning, and emphasizes the idea that the indications for medical or surgical reduction of intraocular tension are based on its influence on function rather than the mere existence of intraocular tension increased beyond the empirical upper limit of so-called normal.

George H. Stine.

Kirwan, E. O'G. **The treatment of epidemic-dropsy glaucoma.** Proc. All-India Ophth. Soc., 1938, v. 6, pp. 122-126. (See Amer. Jour. Ophth., 1939, v. 22, Sept., p. 1042.)

NEWS ITEMS

Edited by Dr. H. Rommel Hildreth
640 S. Kingshighway, Saint Louis

News items should reach the Editor by the twelfth of the month

Deaths

Dr. F. Park Lewis, Buffalo, New York, died September 10, 1940, aged 85 years.

Dr. Sidney Israel, Houston, Texas, died July 17, 1940, aged 53 years.

Miscellaneous

Planned and executed by physicians, a Fair exhibit, entitled "The human eye," opened this summer in the Hall of Science on Treasure Island. The exhibit makes use of a dramatic question-and-answer display technique in an appeal to the public's curiosity concerning medicine. On July 4th its first full day of showing, "The human eye" checked nearly 12,000 people through its visual tests and educational features.

The first question asked of Fairgoers at the exhibit planned by a committee of ophthalmologists, is "How good is your eyesight?" Visitors are given a chance to answer this question by participating in tests for visual acuity and color perception.

"How does your eye work?" is explained by means of a large fresco-diagram which compares the eye with a camera. Another question, "Do you need glasses?" is answered by photographs showing a scene perceived by patients suffering from various refractive errors, and by colored diagrams explaining what causes indistant retinal images in cases of refractive error.

"Is your eye a medical problem?" is graphically explained by glimpses into diseased fundi as recorded on color transparencies. Shown are diseases of the body which affect the eye, diseases of the eye itself, and eye accidents.

"How does the eye physician find out what is wrong?" is a section dealing with diagnosis. Instruments displayed in this section include the ophthalmoscope, slitlamp, tonometer, perimeter, phorometer, and biophorometer. Pathological conditions of the eye are shown by means of fundus and anterior-segment pictures and by diagrams. In emphasizing the importance of refraction by a medical eye physician, the exhibit space devoted to diagnosis includes a diorama of a nurse administering a mydriatic to a patient before refraction.

"How does the doctor help you?" is a question answered by means of an exhibit and an explanation of lenses, and by a section explaining what can be accomplished by eye surgery. An added display likely to attract much interest is a large model of an ophthalmoscope, six feet high, through which visitors may see by turns normal and diseased fundi.

Joint sponsors of the exhibit are the Pacific Coast Oto-Ophthalmological Society and the California Association of Dispensing Opticians.

Societies

The Brooklyn Ophthalmological Society elected the following officers for 1940: president, Dr. Maurice L. Wieselthier; vice-president, Dr. Walter Moehle; secretary-treasurer, Dr. Harold F. Schilback; assistant secretary-treasurer, Dr. I. Jacobs.

The sixth annual meeting of the Mississippi Valley Medical Society was held in Rock Island, Illinois, on September 25, 26, 27, 1940.

The new officers of the Colorado Ophthalmological Society are: president, Dr. William Bane; secretary, Dr. Harry Shankel.

The twenty-fifth international medical assembly, Interstate Postgraduate Medical Association of North America, will be held October 14 to 18, 1940, in Cleveland, Ohio. An address, "Relationship of ophthalmology to systemic disease," will be given by Dr. William L. Benedict.

The annual meeting of the Canadian Ophthalmological Society will be held at the Chateau Laurier, Ottawa, on October 18 and 19, 1940. The subject of the scientific session will be, "New intravenous drugs in ophthalmology." This will be presented under several subtitles. Members of the Council are: president, Dr. W. H. Lowry; vice-president, Dr. F. T. Tooke; secretary-treasurer, Dr. Alexander E. MacDonald; Dr. J. Vaillancourt, Dr. W. G. Fraser, Dr. R. B. Boucher, Dr. R. E. Mathers, Dr. H. P. Folger.

Personals

Dr. Carl Beisbarth announces the removal of his offices to 801 Beaumont Medical Building, Saint Louis, Missouri.

Dr. Arthur C. Smith and Dr. Earle G. Ridall announce the opening of their new offices at 410 West Church Street, Elmira, New York.

Dr. William Burton Clark of New Orleans was recently appointed head of the department of ophthalmology in the school of medicine at Tulane University succeeding Dr. W. R. Buffington, who has retired to devote his full time to private practice. Dr. Clark, a native of Blountstown, Florida, has practiced medicine in New Orleans since 1931, before which he practiced in Ocala, Florida, and Atlanta, Georgia. He was educated at the University of Florida and Tulane and at the Medical College of South Carolina and the Emory University School of Medicine.